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Translation

TANKS AND TANK TROOPS (U)

MARCH 1982

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Translation

TANKS AND TANK TROOPS

Ed. by

A.Kh. Babadzhanyan, et al.

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TANKS AND TANK TROOPS

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ANNOTATION

The volume "Tank i tankovyye voyska" was written by a team of professors and instructors at the Armored Troops Academy imeni R. Ya. Malinovskiy, officers from the central edifice of the USSR Ministry of Defense and from the Guards Kantemirovskaya Tank Division, under the direction of Doctor of Military Sciences Prof Col P. G. Skachko.

The group of authors includes Doctor of Technical Sciences Prof Engr-Maj Gen L. V. Sergeyev; Prof Engr-Maj Gen A. S. Belonovskiy; Doctors of Military Sciences Prof Cols P. G. Skachko, P. Ya. Oreshkin, and N. K. Shishkin; Doctors of Technical Sciences Profs M. K. Maryutin and V. I. Medvedkov; Candidates of Military Sciences Docents Cols S. V. Vasil'yev, V. M. Derevyanskiy, A. V. Polyakov, and V. S. Chernov; Candidates of Technical Sciences Docents Engr-Cols A. G. Burlachenko, N. S. Galandin, V. V. Kiselevskiy, V. A. Mangushev, E. D. Prikhod'ko, and A. G. Solyankin; Engr-Col M. D. Zhurko; Gds Sr Lt V. P. Skachko.

The volume was readied for publication by Cols P. G. Skachko and N. K. Shishkin and Engr-Col V. V. Kiselevskiy.

Chief Mar Armed Trps A. Kh. Babadzhanyan (deceased) served as general editor.

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1. Demands on Tank General Layout and Ways to Achieve Them

The principal task of layout is to ensure excellent preselected tank performance characteristics with the smallest possible weight G, dimnesions L_0, B_0, H_0 (Figure 2.1.1), and cost. The principal way to achieve this is to reduce the vehicle's armor-protected interior space and, consequently, to reduce the overall area of armor protection. Reduction of tank interior space (without cramping the crew and degrading tank performance characteristics) is fostered by selection of the optimal general layout and compact, small-size armament, engine, equipment and mechanisms; dense vehicle layout, with minimum volume of armor-enclosed air; decreasing tank crew size by mechanization and automation of fire control and tank operation; removal of certain secondary, difficult-to-destroy or easily-replaced tank components to the outside of the armor-enclosed space. The protecting thicknesses of hull nose, side and rear armor on the majority of foreign tanks have approximately the ratio 2.5:1:0.5 (Figure 2.1.2). A decrease in height has the greatest effect on increasing hull armor protection (at a given weight); employment of lightweight metal and polymeric materials in tank construction abroad also opens up extensive possibilities for reducing the weight of a tank with specified performance characteristics or improving its performance characteristics while keeping weight constant.

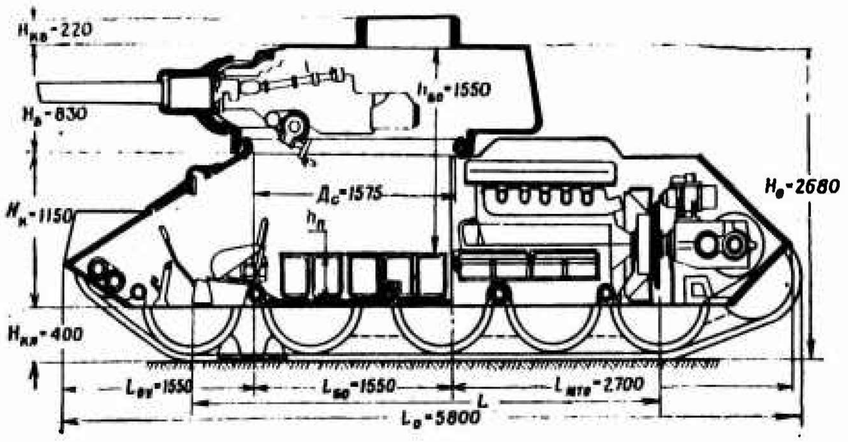

Figure 2.1.1. Diagramatic Layout of T-34 Tank:

L_0, H_0 -- tank dimensions; $Д_c$ -- inside diameter of turret ring; H_k, $H_б$, $H_{kб}$ -- height of hull, turret, commander's cupola; H_k -- road clearance; $h_п$ -- height of interior floor above hull floor; $h_{бо}$ -- height of fighting compartment; L -- length of track bearing surface

---

Another important demand on tank layout is that of installing powerful armament and ensuring its efficient utilization: high maneuverability and accuracy of fire, requisite artillery system rate of fire, and an adequate carried supply of ammunition. This requirement is met chiefly during the particular layout of the tank fighting compartment. Of the general layout measures, we can note only the following: placement of the fighting compartment in the tank midsection, which ensures approximately equal angles of depression when firing forward and rearward, lessens the adverse effect of principal tank pitching movements on the crew, and promotes uniform distribution of ground pressure along the length of the tank track bottom

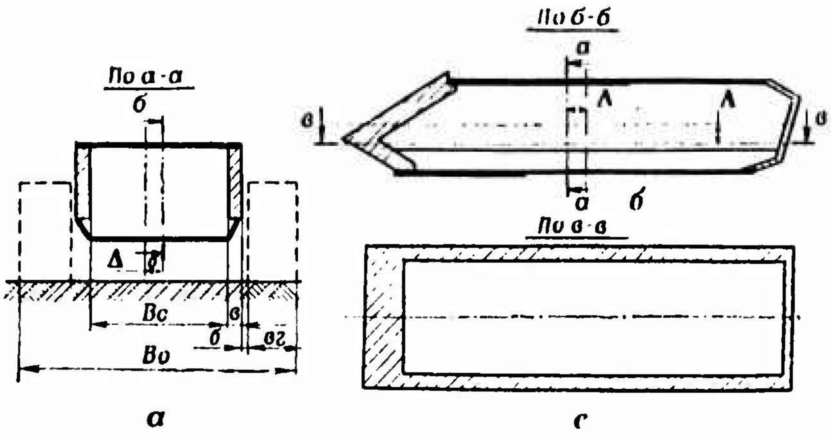

Figure 2.1.2. Schematic Sections of Shellproof Hull:

B_0 -- tank width, including tracks; B_c -- hull interior width; $в_г$ -- track width; $δ$ -- clearance between hull and track

run; large fighting compartment interior volume within the tank hull and turret, running to 6-7 m^3 and comprising 50-60 percent of the vehicle's total armor-enclosed space; large turret ring interior diameter $Д_c$ (see Figure 2.1.1), which limits the size of the artillery system mounted in the turret. This is achieved by maximally increasing interior hull width B_c (see Figure 2.1.2) and additionally widening the upper part of the hull in order to accommodate a large under-turret armor plate.

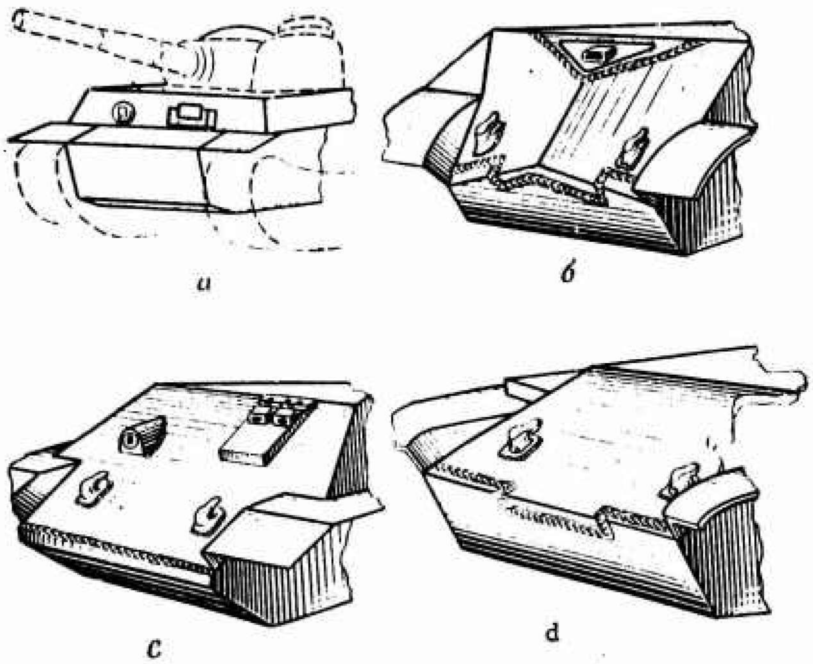

Figure 2.1.3. Tank Hull Nose Shapes: a -- KV; b -- IS; c -- T-34; d -- T-55

Chapter 2. TANK FIREPOWER

1. Armament of Modern Tanks

The mass-scale employment of tanks and other armored vehicles in modern combat dictates heavily arming troops with close and long-range antitank weapons. Therefore tank weapons should be capable of quickly destroying and neutralizing the most diversified targets on the battlefield -- from an individual rocket launcher-firing trooper in a foxhole to a tank and missile weapon launch positions. This also predetermines tank armament.

Tank armament includes weapons, ammunition supply, gunsights, laying mechanisms, weapon stabilizers, and other devices.

Today tanks are armed with a number of weapons, for performing various fire missions. They include, according to a foreign classification, main and auxiliary armament, while some tanks also carry additional weapons. Figure 2.2.1 contains a classification of tank weapons.

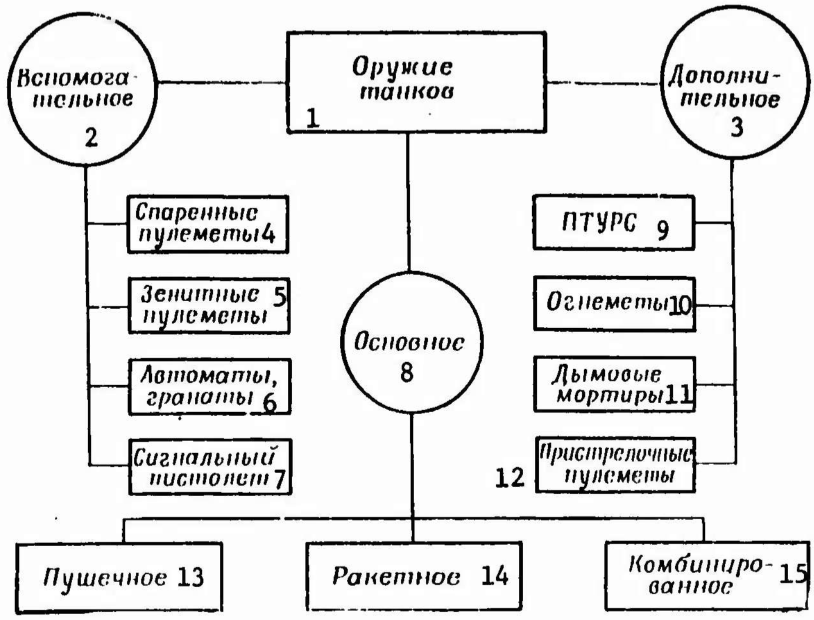

Figure 2.2.1. Classification of Foreign Tank Weapons

Key to Figure 2.2.1 on preceding page:

1. Tank weapons
2. Auxiliary
3. Additional
4. Coaxially mounted machineguns
5. Antiaircraft machineguns
6. Assault rifles, grenades
7. Signal pistol
8. Main
9. ATGM
10. Flamethrowers
11. Smoke dischargers
12. Ranging machineguns
13. Gun
14. Missile
15. Combined

Main weapons are for the purpose of destroying and neutralizing targets possessing considerable firepower and strong protection. These include armored targets (tanks and self-propelled artillery), various field fortifications, enemy artillery and missile launch positions, as well as infantry and infantry weapons. The tank gun is the principal tank main weapon.

The principal type of tank fire is direct fire at all ranges at targets as soon as they are detected. As a rule tank crews independently search for and fire at targets. Tank units deliver concentrated fire at a single target to destroy the most important and largest targets, as well as to accelerate killing of targets at a range of more than 2.5 km.

Auxiliary weapons are used to destroy and neutralize close-range antitank weapons (rocket launchers, recoilless guns, etc), to destroy lightly-armored and slow-flying air targets as well as enemy infantry.

Auxiliary weapons include tank machineguns -- coaxial-mounted, hull-mounted, and antiaircraft. Some foreign tanks carry ranging machineguns.

Additional weapons are employed to perform those fire missions which cannot be successfully accomplished by the principal weapons when delivering fire at long range. This category of weapon includes antitank guided missiles (ATGM), which are carried by some foreign tanks.

The tank gun is mounted as a rule in a rotating turret. The machinegun is mounted on the gun cradle. This combination of gun and machinegun is called a coaxial mounting. The turret is rotated with the aid of electric or electrohydraulic drives operated from a control panel, as well as manually.

The gun (machinegun) is aimed at the target with the aid of a gunsight or rangefinder-gunsight. Night vision sights are provided for firing at night. In addition there are devices for firing under conditions of restricted visibility or when the target cannot be seen.

In order to increase target hit probability when firing while the tank is moving, coaxial mounts are equipped with weapon stabilizers. In order to increase tank gun rate of fire, some tanks (the XM1, for example) feature automatic loading and mechanisms which eject spent cases from the tank.

Thus the armament of a modern tank is a complex system. The firepower of tanks and self-propelled guns is determined by the sophistication of this system and the proficiency of crews.

2. Principal Factors Determining Tank Firepower

A tank's firepower is determined by its capability to destroy or neutralize various targets in the shortest period of time with the least expenditure of ammunition.

Let us examine what principal factors determine a tank's firepower during delivery of fire while moving, when its combat performance characteristics are most fully utilized.

A tank's firepower is determined by the following principal factors: force of effect of a projectile on a target, target hit probability, maneuverability of fire, time of initiation of fire and practical (combat) rate of fire, as well as degree of weapon vulnerability and tank crew habitability.

The interrelationship among the principal factors which determine a tank's firepower when delivering fire while moving can be seen from the diagram in Figure 2.2.2.

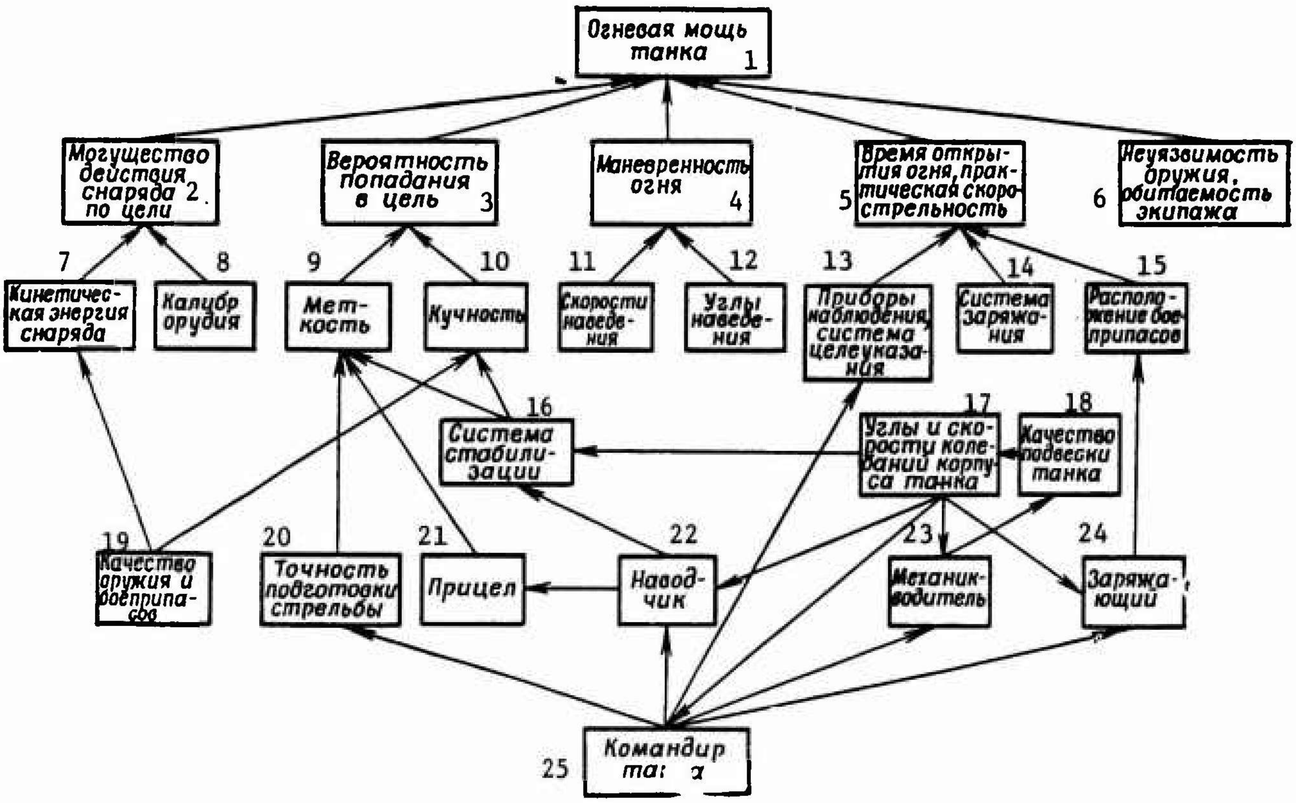

Figure 2.2.2. Diagram of Interrelationship of Principal Factors Which Determine a Tank's Firepower When Delivering Fire While Moving

Key:

1. Tank firepower
2. Force of effect of projectile on target
3. Target hit probability
4. Maneuverability of fire
5. Time of commencement of fire, practical rate of fire
6. Weapon vulnerability, crew habitability

(Key to Figure 2.2.2 on preceding page, cont'd)

7. Kinetic energy of projectile
8. Gun caliber
9. Accuracy
10. Grouping
11. Rates of laying
12. Laying angles
13. Vision devices, target designation system
14. Loading system
15. Location of ammunition
16. Stabilization system
17. Angles and rates of tank hull oscillations
18. Quality of tank suspension
19. Quality of weapons and ammunition
20. Accuracy of fire preparaion
21. Gunsight
22. Gunner
23. Driver
24. Loader
25. Tank commander

A continuous increase in tank firepower has been particularly characteristic of the postwar years. This is due to the fact that tank armament is intended to destroy the most diversified targets on the battlefield, and in particular tanks and antitank weapons. Since the protection of tanks and antitank weapons and their combat capabilities are continuously improving, tank firepower should also increase.

In order to determine the possible paths of future increase in tank firepower, one must analyze the components of each of the principal factors (applicable to the main armament).

3. Increasing the Force of Projectile Effect on the Target

The force of effect by a projectile on a target is determined by the character of the effect it produces upon encountering an obstacle. In order to destroy armored and concrete-protected targets, a projectile should possess considerable impact effect. Projectiles require high explosive or fragmentation effect to destroy various field fortifications and to kill personnel.

At the present time some foreign tanks are employing subcaliber projectiles, shaped-charge shells and shells with plastic explosives against armored targets.

Subcaliber projectiles. Subcaliber is a term applied to projectiles in which the diameter of the armor-piercing portion is less than the caliber of the weapon from which it is fired. The force of effect of a subcaliber projectile is determined by the thickness of the penetrated armor and the effectiveness of the damage done beyond the armor. For a given projectile weight and caliber, armor defeating performance depends on the velocity of the projectile, its angle of impact with the armor, and the quality of the armor. At high angles of impact armor penetration capability is substantially reduced as a consequence of projectile ricochet.

The force of effect of subcaliber projectiles can be increased by increasing their muzzle velocity. This flattens the trajectory, which increases range of direct fire. The greater a projectile's muzzle velocity, the greater its armor-piercing effect, all other conditions being equal. A projectile's muzzle velocity can be increased by increasing propellant gas pressure in the bore and by lengthening the barrel. The latter, however, leads to an increase in barrel size and weight, which creates difficulties in matching it to the tank, and requires an increase in power of gun laying drives.

Long-barreled guns extend considerably beyond the tank hull, which presents a possibility that the barrel will strike the ground when the tank is negotiating obstacles, and it restricts tank maneuver in forest and built-up areas. When projectile muzzle velocity is increased, gun barrel life is sharply reduced, to several hundred rounds.

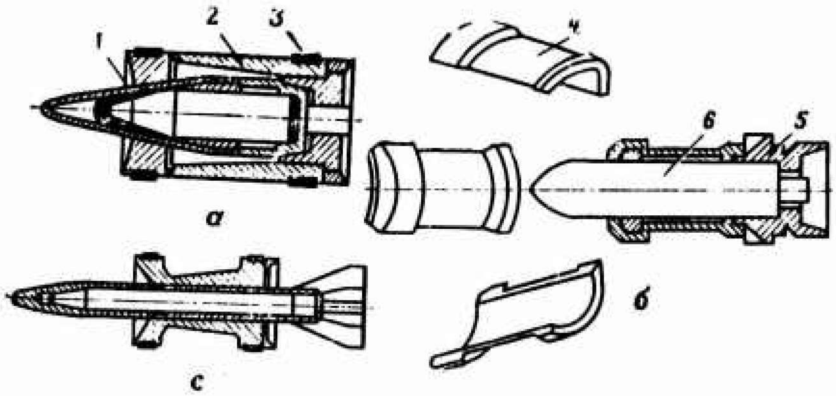

Figure 2.2.3. Projectiles Employed for Tank Guns

a -- subcaliber projectile with discarding sabot; b -- subcaliber projectile with jacket; c -- fin-stabilized subcaliber projectile; 1 -- jacket; 2 -- sabot; 3 -- driving band; 4 -- jacket segment; 5 -- base; 6 -- core

The core of a modern subcaliber projectile is carried in a sabot (Figure 2.2.3). After the projectile leaves the bore, the sabot separates from it, under the effect of air resistance. Possessing a good weight to caliber ratio, the projectile retains its velocity well in flight. A different version of such a projectile is the jacketed projectile (Figure 2.2.3b), which consists of three parts, which separate from the core after leaving the bore. The muzzle velocity of the discarding sabot projectile fired by the British 105 mm tank gun is 1,475 mps.

These subcaliber projectiles, however, ricochet at angles of impact with armor less than 35°, while the discarding sabot can do harm to friendly troops situated ahead of the tank.

It is believed that the kinetic energy of subcaliber projectiles and effective range of fire can also be increased by increasing gun caliber. The British Chieftain tank, for example, carries a 120 mm tank gun, which fires primarily subcaliber projectiles.

Foreign countries are devoting greater attention to smoothbore tank guns firing fin-stabilized subcaliber projectiles (Figure 2.2.3c). 105 mm and 120 mm smoothbore guns, for example, are being tested on the Leopard 2K tank. Similar guns are being developed in Great Britain (110 mm) and France (120 mm). In the opinion of foreign experts, such guns impart greater muzzle velocity to projectiles than rifled guns of the same caliber, boast greater armor piercing capability, range of direct fire, and effectiveness in firing at long ranges. This is due to the fact that the muzzle velocity of a subcaliber fin stabilized projectile can reach 1600 mps and more.

Shaped-charge shells. The principal advantage of shaped-charge shells (Figure 2.2.4a) over conventional armor piercing and subcaliber projectiles is their excellent armor

penetration with the same caliber, which is independent of range of fire. A nose fuze actuates upon impact with armor. Its action is transferred to an igniter, which detonates the bursting charge through a detonator. The metal liner is squeezed under a pressure of several hundred thousand atmospheres. A jet of molten metal is ejected from the cone (Figure 2.2.4b) at a velocity of approximately 10,000 mps. The diameter of the jet in medium caliber shells is 3-4 mm. The jet is capable of penetrating armor of a thickness in excess of three times the caliber of the projectile.

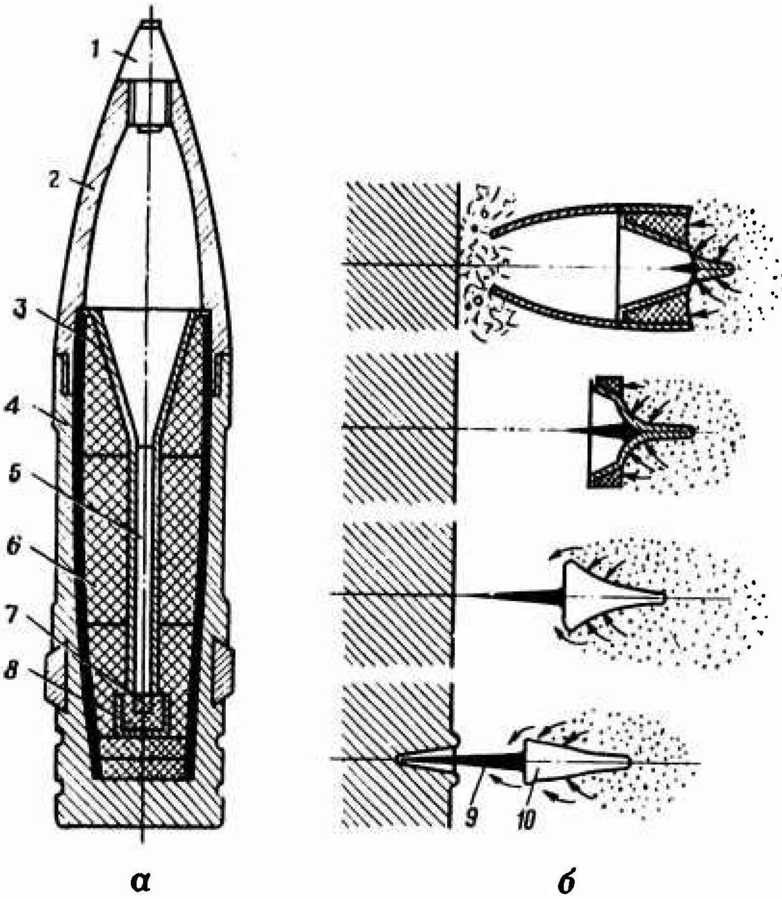

Figure 2.2.4. Shaped-Charge Shell and Diagram of Formation of Jet

Key:
- a. Shaped-charge shell
- b. Diagram of formation of jet
- 1. Direct action fuze
- 2. Screw-on nose cap
- 3. Metal liner (cone)
- 4. Shell body
- 5. Central channel
- 6. Bursting charge
- 7. Igniter
- 8. Detonator
- 9. Jet of molten metal and gas
- 10. Slug

Foreign experts are of the opinion that the armor piercing capability of shaped-charge projectiles is reduced severalfold if the projectiles are rotating at the

moment the bursting charge explodes. This is due to the fact that projectile rotation worsens the conditions of forming of the jet.

They believe that the force of shaped-charge projectiles can be increased by slowing their rate of rotation. Projectiles fired from rifled tank guns spin in flight at approximately 17,000-18,000 rpm, which greatl) exceeds the maximum allowable spin rate for shaped-charge projectiles. In order to reduce the spin rate, one can employ a shaped-charge projectile the steel body of which is imparted spin when fired, while the shaped charge, on ball bearings inside the projectile body, remains motionless by inertia. Such a projectile is employed for the 105 mm tank gun of the French AMX-30 medium tank. The manufacture of such a shell requires a high degree of machining precision, which greatly increases its cost.

Projectiles with plastic explosives. Some foreign tanks employ projectiles with plastic explosives against armored and other targets. The mild-steel projectile body is filled with a plastic explosive (a mixture of hexogen and mineral oil). The projectile body readily deforms upon impact with armor. A base fuze detonates the explosive, a compression wave followed by a tension wave passes through the armor, and armor layers on the rear of the plate are imparted enormous accelerations in opposite directions. As a result of this, pieces of armor split off the interior of the plate at high velocity, doing damage to the tank interior.

These projectiles can also be employed against field fortications and unarmored targets.

In the opinion of foreign experts, projectiles with a plastic explosive also have an important drawback: they must be detonated at a precisely established time. Bursting charge detonation time depends on the projectile's terminal velocity and angle of impact with armor, values which vary in relation to range. Therefore the velocity of such projectiles is comparatively low. In addition, skirting plates and other devices can be employed against plastic-explosive projectiles, sharply reducing their casualty effect.

At the present time plastic-explosive projectiles have been adopted for the guns of the U.S. M60 tank, the British Chieftain tank, and the Swedish STRV103B tank.

High-explosive fragmentation shells. High explosive fragmentation shells are used to engage antitank weapons, to kill enemy personnel in an exposed position, to demolish defensive installations, etc.

When an instantaneous fuze is employed, high-explosive fragmentation shells perform as fragmentation shells, and as high explosive shells when employing a graze or delayed action fuze.

Fragmentation effect depends on the quantity of lethal fragments, their pattern of spread, the projectile's angle of descent, depth of crater, character of the soil, and other conditions. Only those fragments the kinetic energy of which is not less than 10 kg/m are lethal. The most efficient fragment weight is q_0=5 grams; lighter fragments rapidly lose velocity, while with greater weight the number of fragments is reduced.

SECTION VI. COMBAT OPERATIONS OF TANK TROOPS

Chapter 1. NUCLEAR WEAPONS AND TANKS

1. Nuclear Weapons and Their Casualty-Producing Elements

Weapons the effect of which is caused by the release of energy in processes taking place within the nuclei of the atoms of certain elements are called nuclear weapons. As we know, in the detonation of conventional explosives, energy is released as a result of chemical reactions.

Devices designed to effect the explosive process of liberation of energy within the atomic nucleus are called nuclear warheads. There are two principal types of nuclear warhead, differing in character of explosive reaction: fission nuclear warheads (atomic warheads), and thermonuclear. In fission-type nuclear warheads, energy is released as a result of fission reaction of the nuclei of atoms of certain heavy elements (plutonium 239, uranium 235, uranium 233, etc). In thermonuclear warheads, in addition to a fission reaction, there occurs a fusion reaction of atomic nuclei of certain light elements (lithium, hydrogen isotopes -- deuterium and tritium, etc). Combined nuclear warheads are also possible.*

Nuclear explosions are accompanied by the release of a vast amount of energy. The yield ratings of nuclear warheads are determined not by their mass or size (caliber) but by the quantity of energy released when they explode. It is compared with energy released in the explosion of the most widespread explosive, TNT. The power of a nuclear warhead is measured in a TNT equivalent, the amount of TNT in tons (in thousands of tons -- kilotons; in millions of tons -- megatons), the explosion of which releases an equal amount of energy as in the explosion of a given nuclear warhead.

According to reports in the foreign press, at the present time there exist nuclear warheads with TNT equivalents ranging from several tons to tens of millions of tons (megaton). As we know, in August 1945 the Americans dropped atomic bombs with a TNT equivalent of 20,000 tons (20 kt) on the Japanese cities of Hiroshima and Nagasaki.

The following can carry nuclear warheads in the armies of the capitalist nations: missiles of various designation, aircraft bombs, artillery shells, torpedoes, and mines (nuclear landmines).

* See M. Namias, "Nauka i oborona" [Science and Defense], Moscow, Mir, 1969.

Nuclear warheads can be exploded in the air at low and high altitudes, at the ground (water) surface, and underground (under water). The external picture of a burst differs for different types of explosions.

The following casualty-producing elements are produced from the burst of a nuclear warhead: a powerful shock wave, luminous radiation, penetrating radiation, an electromagnetic pulse, plus radioactive contamination of the ground and objects. The blast wave causes casualties, destroys or disables combat equipment, weapons and structures. Luminous radiation causes fires, burns the skin, damages the eyes and causes temporary blindness in humans and animals. Penetrating radiation (gamma rays, neutrons) cause radiation sickness in personnel. Radiation is given off from contaminated ground and objects, producing the same effect on humans as penetrating radiation at the time of a nuclear burst. Radioactive dust particles can enter the organism of humans and animals together with air, water and food and can cause damage.

Penetrating radiation ionizes the atoms of the medium through which it passes. The degree of ionization of a medium is determined by dose of penetrating radiation, measured in roentgens. A roentgen is a radiation dose with which approximately 2 billion pairs of ions are formed in one cubic centimeter of dry air under standard conditions.

The casualty-producing effect of penetrating radiation on humans and animals depends on the magnitude of the received dose and the time in the course of which it is received.

The electromagnetic pulse damages control and communications equipment and disables radioelectronic gear.

The casualty-producing elements of a nuclear burst differ one from another in character, time and range of effect on personnel, combat equipment, weapons and structures, depending on the location (ground zero) of the burst.

The casualty effect of shock wave, luminous radiation, penetrating radiation and electromagnetic pulse is estimated on the basis of radii and areas of lethal areas. Depending on the yield of a nuclear warhead, type of burst, character of stricken objects and their degree of protection, the radii of casualty and damage effect, according to figures published abroad, will range from tens of meters to tens of kilometers (Figure 6.1.1). To estimate personnel casualties, one employs radii of zones of general effect of shock wave, luminous radiation, and penetrating radiation.

Warhead yield, type and location of burst relative to the target are determined by the mission, with the objective of inflicting maximum damage under the given conditions.

Radioactive contamination of terrain (water, equipment, etc) can occur over large areas and at considerable distances from ground zero (tens and hundreds of kilometers) and can affect personnel for an extended period of time. This is determined by the yield and type of burst, wind direction and velocity.

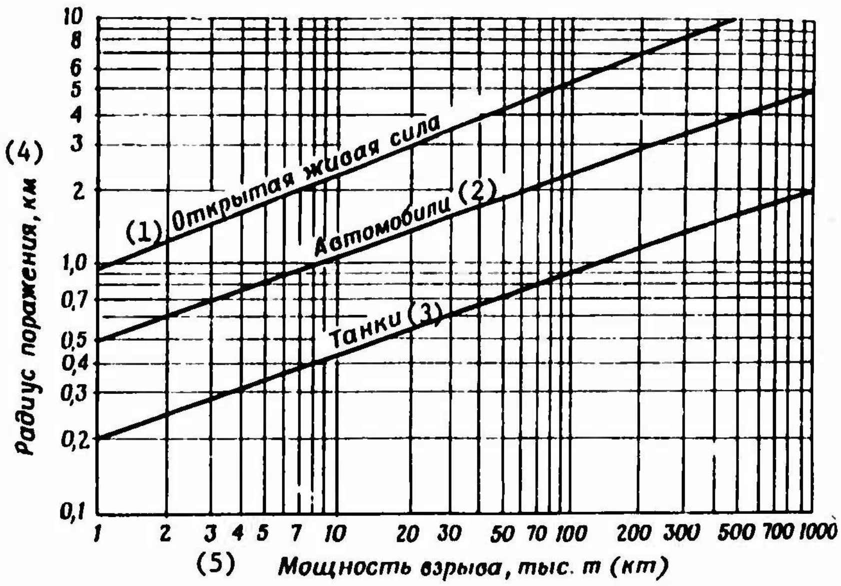

Figure 6.1.1. Nuclear Burst Damage and Casualty Radii*

Key:
1. Exposed personnel
2. Trucks
3. Tanks
4. Damage/casualty radius
5. Yield of burst, thousand tons (kt)

In addition, a zone of physical destruction and tree blowdown, which presents advancing troops with a substantial obstacle, is created in nuclear strike areas.

The destructive power of nuclear weapons is many times greater than that of shells and bombs carrying conventional explosives. For example, dozens of guns and mortars were employed during World War II to neutralize a well equipped strong point, thousands of shells would be expended, and considerable time would be required. Today this mission can be effectively accomplished in short order with a single nuclear warhead of appropriate size. Several nuclear warheads are capable of putting a unit and even a combined unit out of action.

2. Protective Properties of Tanks Against the Casualty-Producing Elements of Nuclear Weapons

Of all types of modern combat vehicles, the tank possesses the greatest resistance to damage and casualty-producing factors of a nuclear burst and provides the most reliable crew protection. A tank fully protects its crew against luminous radiation and substantially attenuates the effect of the shock wave and penetrating radiation. The tank's airtight seal protects the crew against radioactive dust entering the organism together with inspired air and against coming into contact with exposed parts of the body.

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* Table based on figures from: M. Namias, "Nauka i oborona."

Tanks sustain structural damage from a nuclear burst at comparatively close distances from ground zero, as a result of the powerful shock wave. According to figures in the foreign press, for example,* tanks sustain considerable damage with a shock wave overpressure exceeding 2-3 kg/cm^2 (20-30 t/m^2). The overall force of impact on a tank in such instances exceeds 100 tons, which overturns it or throws it back several meters. Tanks sustain minor and medium damage with a shock wave overpressure of 1-2 kg/cm^2 (10-20 t/m^2). With damage of this magnitude, tank mobility is usually preserved. For example, with approximately 30 kt nuclear warhead bursts, heavy damage is observed within a radius of up to 250 meters from ground zero, medium damage -- up to 500 meters, and slight damage -- up to 1000 meters. On the basis of the law of similarity, radii of damage/casualties with two warheads exploding relate to one another as the cube roots of their yields:

$$r_1 : r_2 = \sqrt[3]{q_1} : \sqrt[3]{q_2} = \sqrt[3]{q_1 : q_2},$$

where r_1, r_2 -- casualty zone radii; q_1, q_2 -- warhead yields corresponding to these radii.

Utilizing this property, one can calculate the casualty zone radii of objects if the casualty zone radius is known for a given warhead yield. For example, with the burst of a 300 kt nuclear warhead, the radius of the casualty zone will increase not 10-fold in comparison with that of a 30 kt warhead, but only

$$\sqrt[3]{300:30} = \sqrt[3]{10} \approx 2 \quad \text{twice.}$$

Consequently, with a 300 kt burst, considerable damage to tanks will be observed within a radius 2 x 250=500 m, medium damage -- 2 x 500=1000 m, and slight damage -- 2 x 1000=2000 m.

A material's protective properties against penetrating radiation are determined by the half-value thickness. This is a thickness of a given material which cuts a radiation dose in half. Knowing the half-value thickness d_0, one can calculate the attenuation factor k of a barrier of any thickness d of that material according to formula

$$k=2^{\frac{d}{d_0}}.$$

It is noted that the half-value thickness of armor is 3 cm for gamma rays and 10 cm for neutrons. Consequently armor with a thickness d=20 cm attenuates gamma rays $k_{g-r}=2^{\frac{20}{3}}=2^{6.7}\approx 100$ times, and a neutron flux -- $k_n=2^{\frac{20}{10}}=2^2=4$ times.

Materials consisting of elements with light nuclei do a better job of attenuating neutron fluxes than gamma rays. For example, the half-value thickness of certain plastics is d_0=3 cm for neutrons and d_0=15 cm for gamma rays. A layer of such plastic 10 cm thick attenuates a neutron flux approximately $k_n=2^{\frac{10}{3}}=2^{3.3}\approx 10$ times.

According to data in the foreign press, some modern tanks attenuate radiation doses approximately 10-fold, which provides sufficiently reliable crew protection during operations in radioactive contamination zones following nuclear strikes.*

* M. Namias, "Nauka i oborona."

A further increase in the strength and stability of tanks and their protective properties against the effect of penetrating radiation on crew members is needed to increase survivability of tank troops in conditions of employment of nuclear weapons. Materials containing elements with heavy and light nuclei are employed abroad for accomplishing this task.

3. Utilization of Tanks During Employment of Nuclear Weapons

It is undisputed that arming tank troops with nuclear weapons decisively increases their firepower and striking power and radically alters the content and character of modern combat. Tanks, which are more resistant to the casualty-producing elements of the nuclear burst, can most effectively exploit the results of nuclear strikes delivered on the adversary and secure conditions for his total defeat. The principal content of the combined-arms engagement will be destruction of the adversary's nuclear weapons and main forces with nuclear strikes, with a subsequent swift tank advance through breaches opened in the enemy's defense.

It is believed that missile and artillery subunits of tank troops should possess a high degree of mobility and be positioned in the tank combat formations. In addition, nuclear airstrikes can be delivered against enemy mobile targets for the benefit of tank troops.

It is stated in the foreign literature that nuclear weapons will be employed against the most important enemy targets. Such targets in the offensive engagement include nuclear weapons, strong points and centers of resistance, reserves, artillery and tank subunits, control facilities, and supply depots; in the defense -- nuclear weapons, attacking forces during their approach and deployment, and reserves.

Foreign experts believe that high airbursts will be most frequently employed in offensive types of combat actions: in the area of the bursts the ground is contaminated to an insignificant degree, which will present practically no hindrance to the advance of tanks. Low-altitude airbursts can be employed against solid defensive works and tanks. In a number of instances contact surface bursts will be employed against important targets deep in the enemy's defense. The adversary will additionally sustain numerous casualties from heavy contamination of terrain.

As a result of nuclear bursts, enemy subunits and units will fully lose their battleworthiness within the boundaries of personnel disabling casualty zones. Troops will be neutralized over a substantial area and for a certain period of time will be unable to offer organized resistance to the advancing forces.

Tanks alone are capable of swiftly attacking the enemy through breaches on the heels of nuclear strikes, of destroying surviving enemy personnel and weapons, of crossing radioactive contamination zones and tree blowdown, and reaching the opposite side of the nuclear burst area in the shortest period of time.

It is believed that when tanks emerge from a nuclear strike zone, they may encounter organized resistance by surviving antitank weapons or weapons moved up from the reserve. These weapons should be immediately destroyed by concentrated tank and artillery fire, while advancing reserves should be destroyed by missile and airstrikes. Only decisive offensive actions by tanks and their rapid pace of

advance will prevent the adversary from restoring his battleworthiness following a nuclear strike and will ensure his defeat.

With the employment of nuclear weapons it is essential strictly to observe safety procedures for friendly troops. Nuclear strike targets, warhead yields, as well as types of bursts are selected taking into account the safety of friendly troops. Troop safety lines are figured in advance and marked on the map and on the terrain on the basis of prominent landmarks (Figure 6.1.2). Taking into consideration the fact that terrain possesses substantial protective properties against the casualty-producing elements of a nuclear burst, one must skillfully utilize it to reduce friendly troop casualties. At the same time one must bear in mind that the terrain will change substantially in the nuclear strike area: entire structures and even built-up localities will disappear, certain bridges will be destroyed and woods will burn. The result will be that no landmarks will remain, creating substantial difficulties for advancing troops to gain their bearings.

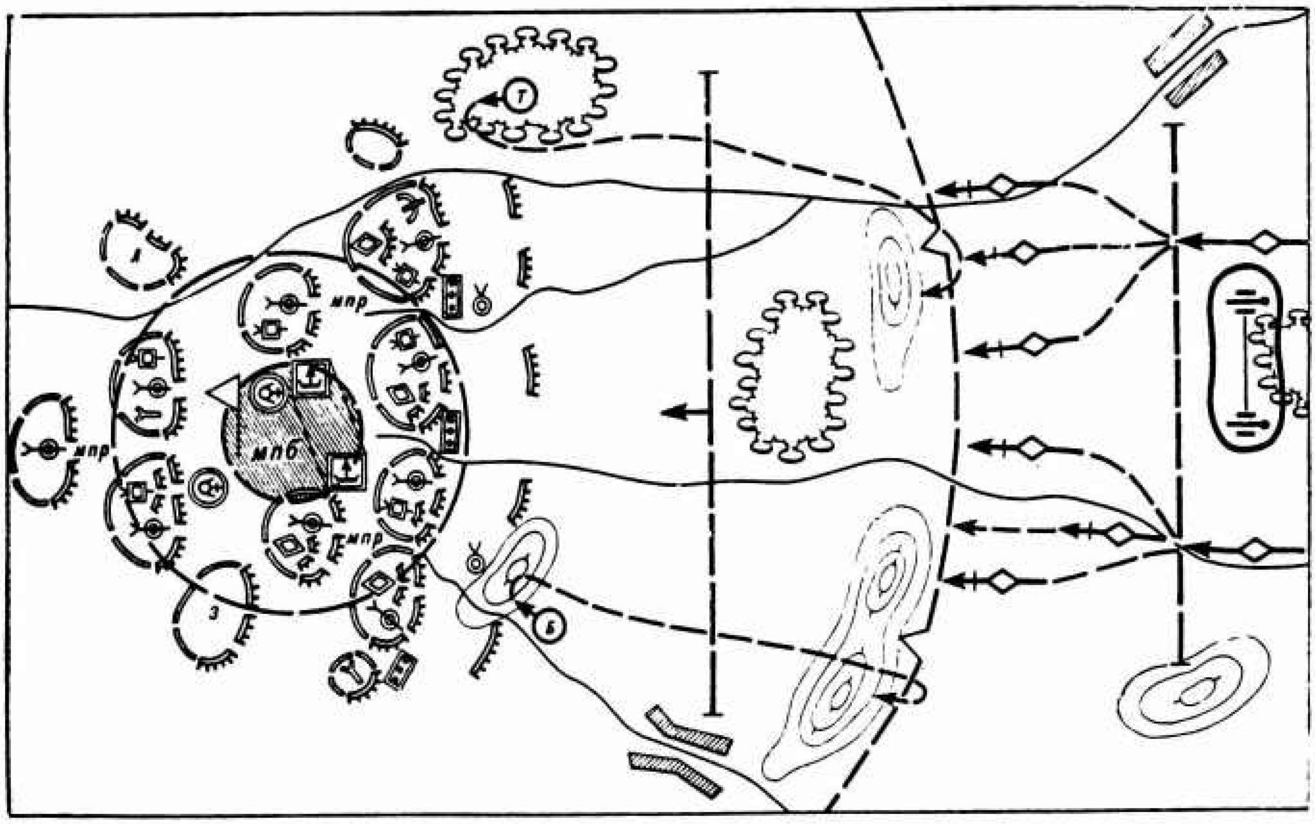

Figure 6.1.2. Safety Procedures When Delivering a Nuclear Strike During a Subunit Attack Without a Halt in Attack Position (Variant)

Key:
- мпб -- motorized infantry battalion
- мпр -- motorized infantry company

Under these conditions, when assigning missions to subunit commanders and vehicle crews, it is necessary to indicate stable landmarks, the potential character of terrain change, and to specify measures to provide comprehensive and timely support of the tank advance.

Advancing tanks should themselves reconnoiter routes for bypassing physical destruction and tree blowdowns, conduct radiological reconnaissance, and should cross blowdown and physical destruction areas with their own resources and without a halt.

Chapter 2. TANKS AGAINST ANTITANK WEAPONS

Antitank weapons which can be aggressively employed against tanks include the following: tactical and operational-tactical nuclear weapons, aircraft, artillery, enemy tanks, engineer troops antitank weapons, as well as ground troops antitank weapons, particularly antitank guided missiles (ATGM).

The experience of the war in Vietnam and particularly in the Near East demonstrated convincingly that ATGM are the most effective of all the above listed weapons, disregarding nuclear weapons. Therefore in this chapter, following a brief review of antitank weapons, principal attention will be focused on tank combat against ATGM.

1. Possible Actions Against Tanks

Foreign military experts believe that in conditions where there is no close contact between the opposing sides, tanks may be subjected to attack by tactical nuclear weapons, aircraft, and ground troops.

In their opinion, tactical nuclear weapons can be employed against hostile tanks at a considerable distance. Experiments conducted abroad have indicated, however, that employment of medium yield nuclear warheads (10-100 kt) against tank forces is little effective without precise information on their location. The results of employment of nuclear weapons will also be relatively limited when employed against already dispersed enemy combat formations. It is considered in the foreign military press that employment of nuclear weapons usually produces the greatest effect against already engaged units, the location of which is precisely known.

It is stated in the foreign literature that aircraft, in addition to bombing lines of communication, with the objective of impeding the movement of hostile mechanized and tank troops and disrupting their logistical support, should kill even well-protected tanks with direct fire. Aircraft are armed specifically for this mission with missiles carrying a shaped-charge warhead.

It is noted that in combat, due to complexity of control, one cannot count on air support in engaging tanks. Therefore the foreign military press expresses the view that ground troops should employ primarily helicopters to combat tanks; helicopters, working in coordination with a ground force, supplement and increase the capabilities of other antitank weapons. Since helicopters are vulnerable to antiaircraft weapons, however, they should skillfully utilize terrain

irregularities for concealment and fire their ordnance from a standoff distance, remaining beyond the range of hostile light antiaircraft weapons.

It is believed that joint actions by helicopter gunships and tanks or tank destroyers increase the effectiveness of each of these weapons. A helicopter's radius of action and speed enable the command to concentrate a large number of helicopters in a tank massing area and to shift them to another area in a relatively short period of time. A sufficient number of helicopters armed with missiles can change the course of battle. At the present time helicopters are armed chiefly with manually controlled ATGM (type SS-11). They have a range of 3,000 meters. Work is in progress on increasing the range and effectiveness of these missiles.

Great Britain, the FRG, France and the United States developed the Swingfire, HOT and TOW antitank missiles. The French-West German HOT ATGM is presently the only one with an effective range of 4,000 meters. It is believed that this promising missile will become the principal helicopter weapon.

Artillery in turn can deliver fire on tanks the location of which is known. In the opinion of Western military experts, however, artillery rounds are currently poorly suited for engaging tanks. The French 155 mm fragmentation shell, for example, possesses sufficient penetrative power, but it too has proven little effective.

Attempts are presently in progress abroad to develop cluster rounds. These projectiles, bursting in the air above tanks, scatter warheads which damage the tanks. It is noted that this solution to the problem of engagement of tanks is more suitable for rocket projectiles fired by salvo-fire rocket systems. Efforts are in progress to fit tactical missiles with antitank warheads. Each warhead contains a shaped charge and heat-seeking head, which seeks out, locks onto and destroys a tank on the battlefield.

It is believed that tanks which are widely scattered over the terrain (which is essential in combat with threatened employment of nuclear weapons) are a poor target for field artillery, requiring an excessive expenditure of ammunition. Approximately 10 tons of ammunition must be expended in order to destroy with a 50 percent probability half of a subunit consisting of 10 tanks dispersed over an area of 0.2 km^2.*

It is believed that in combat with enemy tanks and mechanized forces, the principal role will be played by tank and mechanized units; crews of self-propelled antitank guns or missile launchers will also be involved, and helicopter gunships will have greater importance.

Special tank destroyer companies have been established in FRG brigades to combat tanks.

France has not taken the path of building heavy self-propelled antitank guns but has opted for a light tank (tank destroyer), following the concept of "maximum firepower with minimum tank weight."

* See [Zh. Marzloff], "Combating Tanks," REVUE MILITAIRE GENERALE, July 1972.

In order to improve the AMX-13 tank, a 90 mm gun was mounted on it, and subsequently a 105 mm gun. Thus a fairly effective weapon was developed for combating tanks at medium ranges. France has also launchers armed with Harpoon ATGM, with a semi-automatic guidance system.

As already noted, there is presently going on a debate abroad on whether to arm a tank with a gun or antitank missiles.

It is noted that the most modern of the ATGM being developed, the Acra, travels at a speed of 520 mps, that is, two or three times slower than antitank artillery shells. A gun is more convenient, since in combat speed of actions and accuracy of fire are of primary significance.

A gun mounted on a heavy tank can be highly accurate at ranges up to 3,000 meters. The gun on the AMX-30 tank, for example, is almost sure to hit any stationary target at a range of 2,800 meters if range to target has been accurately measured with a laser rangefinder.

When firing at moving targets and in unfavorable conditions (in a strong wind), however, the target hit probability of an antitank missile is greater than that of an artillery shell. The difference in these probabilities increases with an increase in range to target. Thus it is believed that while the gun is the best armament for a tank, the missile should be the principal antitank weapon. In direct fire positions ATGM and antitank guns will supplement one another. According to foreign data, an ATGM is 15-20 times more expensive than a modern antitank artillery shell, and therefore it is recommended to be employed when really necessary. Engineer subunits can also combat tanks. They possess effective antitank weapons -- landmines of various modifications. French side armor penetration mines, which can penetrate 75 mm of armor within a radius of 40 meters, are effective, for example. These mines are difficult to detect, since they are made of non-metallic components. It is stated in the foreign literature that although these measures against tanks do not inflict heavy tank losses on the enemy, they do slow their advance.

In close combat tanks are also engaged by other ground troops antitank weapons. Infantry play a special role in this. But the main thing is that all subunits and units -- artillery, engineer, combat service, etc -- are armed with antitank weapons enabling them to engage tanks in close contact.

It is believed that troops should be armed with light, man-portable weapons which are sufficiently effective against the heaviest tanks and which boast a high accuracy of fire at considerable range. Existing antitank weapons are subdivided into individual and crew-served.

Individual antitank weapons include light grenade launchers and antitank rocket launchers, such as the M72 (United States), ARPAC and SARPAC (France).

Crew-served antitank weapons usually are assigned to squads or platoons. They include antitank rocket launchers, the range of which has increased to several hundred meters as equipment has improved. The armies of many countries would like to have antitank rocket launchers with an effective range of 1,000 meters. The range of modern crew-served weapons can exceed 300 meters (the F-1 STRIM antitank rocket launcher) and can be as much as 500 meters (APX-80).

Advances in rocketry make it possible to consider some ATGM today also as individu: - weapons. For example, the MILAN ATGM can be included in this group. Two men can easily carry it with two rounds a fairly substantial distance. When ATGM are employed as individual weapons, effective range increases from 300-500 m to almost 2,000 m. It is believed that the MILAN ATGM will replace crew-served weapons -- recoilless guns and ATGM of the preceding generation. Such an ATGM can also be mounted on infantry combat vehicles, which will kill tanks at a range of up to 2,000 meters.

Foreign experts conclude that principal attention in the area of antitank weapons is being focused on increasing rate and accuracy of fire at targets at any range. Efforts are not restricted to development solely of heavy weapons. Light antitank weapons today have a range of up to several hundred meters. Attention is also devoted to small-caliber automatic antitank guns, which are a fairly effective means of combating light tanks.

In the French Army, for example, there are actually no special antitank units and subunits, with the exception of AMX-13 tank platoons, ATGM subunits of mechanized regiments, and ground forces light aviation helicopter gunship sections. In each mechanized platoon squad, in addition to antitank mines and grenades, there is an F-1 STRIM antitank rocket launcher or two MILAN ATGM, which can be fired either from the ground or from the AMX-10P vehicle.

The shaped charge is the basis of the majority of antitank rounds. It is believed that, proceeding from current conditions, ATGM will evidently be employed against targets at medium and long ranges. It is recommended that helicopters be utilized for this. Therefore Alouette helicopters are being armed with SS-11 and other antitank missiles.

In the ground forces of the FRG, divisions and army corps do not have independent antitank subunits, although the army corps tank regiment is viewed as a reserve for combat against tanks. Tank and motorized infantry brigades contain tank destroyer companies armed with antitank guns and missiles. Infantry (jaeger) battalions contain heavy weapon companies armed with weapons for combating tanks. Antitank weapons at various echelons of combined-arms units include the Energa 75 mm rifle grenade, the Panzerfaust 44 mm antitank rocket launcher, the Karl Gustav 84 mm antitank rocket launcher, the Cobra or SS-11 ATGM, as well as 90 mm self-propelled and auxiliary-propelled antitank guns.

In the ground forces of Great Britain, the principal antitank weapons include the Wombat 120 mm recoilless gun, the Vigilant ATGM (or Swingfire ATGM), the Karl Gustav antitank rocket launcher, Rarden 30 mm antitank guns mounted on FV432 Trojan armored personnel carriers, and Energa rifle grenades.

In armored cavalry reconnaissance regiments, 15 out of 45 Ferret armored cars are armed with Vigilant ATGM. Eight out of 11 tank battalions contain platoons of FV432 Trojan armored personnel carriers armed with Swingfire ATGM.

The question of employment of helicopters to combat tanks occupies the attention focus of experts.

Primary significance is also attached to combat against tanks in the U.S. Army. In the army corps, an armored division contains M60 main battle tanks of various modifications, and M551 Sheridan light tanks. Airmobile companies contain helicopter gunship sections. In the division, the tank battalion is the principal element of organization of antitank defense.

Motorized infantry and infantry units are armed with 90 mm recoilless guns. Fire support companies are armed with 106 mm recoilless guns, while some have TOW ATGM. The 66 mm grenade launcher is an individual antitank weapon. Airmobile units are armed with 90 mm guns, 40 mm grenade launchers, and ATGM (SS-11, TOW).

Thus it is believed that ATGM are the principal means of combating tanks.

2. Modern Antitank Guided Missiles (ATGM) and Their Influence on Tank Operations

The war in the Near East demonstrated the great effectiveness of ATGM: seven out of every 10 tank kills were by ATGM. In connection with this, foreign military experts reached the conclusion that in order for the tank to be able to dominate the battlefield in future wars, it must possess a high degree of survivability and be capable of successfully combating a new and formidable adversary -- the antitank guided missile.

The development of ATGM gave rise in some foreign military experts to doubt about the advisability of employing tanks in modern warfare. Even opinions to the effect that the tank is no longer viable were expressed. Practical experience and the events of recent years, however, have refuted these forecasts.

We know from past experience that when a new weapon has appeared, no matter how formidable, there has always been found a weapon to localize it or to reduce its effectiveness to a minimum.

It is believed abroad that this has also occurred with regard to the ATGM. At first, in proving ground tests and at the first stage of the war in the Near East, they seemed truly omnipotent, capable of changing the role of tanks on the battlefield. But a subsequent thorough study demonstrated that such a conclusion was premature. The new weapons contain deficiencies which enable tanks to operate successfully. And just as war chariots, beginning with the time of Alexander the Great, inspired terror in the infantry and cavalry phalanxes, modern tanks will continue for many years to come to maintain absolute domination of future battlefields. In order to see this, one must analyze the capabilities of ATGM and methods of combating them.

A brief analysis of modern ATGM will elucidate their positive and negative characteristics. Table 6.2.1 lists antitank guided missiles presently operational and under development in the most highly equipped foreign armies, and their performance characteristics.

Foreign military experts subdivide ATGM into three generations, based on guidance system and period of development, as well as when they became operational: first, second, and third generation.

At the present time the ground forces of the NATO armies are armed with first-generation ATGM, which became operational at the end of the 1950's and beginning of the 1950's, and improved second-generation ATGM, which became operational at the end of the 1960's and beginning of the 1970's.

First-generation ATGM are characterized by a manual guidance system. They include the Vigilant, Cobra, and ENTAC light ATGM, with a range of 1,400-2,000 meters, the heavy SS-10, SS-11, and SS-12, with a range of 3,500-6,000 m, plus others. One feature of these ATGM is guidance by the "three points" method and the existence of a large safe zone -- 200-500 m. Foreign military experts note that this is a major drawback of first-generation ATGM.

In the opinion of these experts, positive aspects of first-generation ATGM include a high degree of effectiveness of fire (mean target hit probability 0.75-0.8) and 530-700 mm armor penetration.

Second-generation ATGM have a semiautomatic guidance system, which made it possible substantially to increase ATGM maximum speed (to 300-850 mps) and target hit probability to 0.8-0.9 and more (to 0.94-0.99 for the Shillelagh ATGM).

Second-generation ATGM are subdivided, in conformity with the NATO classification, into two groups: light (man-carried) missiles with a range up to 2,000 m (MILAN, Dragon), and heavy (vehicle-carried) missiles (TOW, Shillelagh, HOT, SS-11B1), with a range to 4,000 meters and more. The safe zone of the second-generation ATGM sharply decreased -- to 25-75 and 200-300 meters.

Launchers for the majority of heavy ATGM are mounted on an armored chassis (APC, ICV, tanks), as well as on helicopters and fixed-wing aircraft.

According to figures in the foreign press, second-generation ATGM will be in service with NATO forces up to the middle of the 1980's, after which they will be replaced by third-generation ATGM.

Third-generation ATGM, as foreign experts note, will be characterized by improved guidance systems, high speed, light weight and small size. Semiactive homing guidance heads and laser target illumination will increase their combat effectiveness and provide capability to deliver fire on a target when the launcher is both in a direct and indirect fire position. It is anticipated that third-generation ATGM will begin to become operational in NATO nation armies by 1980.

It is evident from Table 6.2.1 that ATGM in service can penetrate armor 400-700 mm in thickness. Such effectiveness is due to the fact that all ATGM are designed according to the principle of utilizing a shaped-charge jet of gases of highly-effective explosives possessing a high temperature, high velocity, and enormous pressure at the focus of the jet. As has been reported in the foreign press, armor piercing capability of ATGM presently under development will be not less than the figures specified in the table. Thus, as regards armor defeating performance, ATGM are extremely dangerous to tanks, and therefore, it is believed abroad, increasing tank survivability should be achieved primarily by increasing tank armor resistance to shaped-charge projectiles and diminishing the shaped-charge effect of antitank guided missiles.

Performance Characteristics of ATGM of Foreign Armies

Table 6.2.1

ATGM Designation	Country Where in Service	Guidance System (In-Flight Guidance)	Weight, kg, of Missile (Warhead) / System	Range of Fire, m Maximum / Minimum	Thickness of Armor Piercing Capability, mm / Maximum Speed m/s	Length, mm / Diameter (Size of Stabilizer), mm	Launcher Location
1	2	3	4	5	6	7	8
		First Generation					
SS-10	France (1955), no longer produced	Manual, wire-guided	15(5) / .	1600 / 300	500 / 80	860 / 164(750)	Armored cars, light tanks
SS-11	France (1958), series production; NATO countries	Manual, wire-guided (aerodynamic)	28.4(6) / 30	3500 / 500	600 / 190	1160 / 164(500)	Portable launchers, launchers mounted on trailers, trucks, APC, tanks, helicopters, fixed-wing aircraft
SS-12	France (1965), series production; NATO countries	Manual, wire-guided (jet vanes)	75(3) / .	6000 / 800	600—700 / 240	1870 / 210(650)	Trucks, APC, helicopters, patrol craft
Vigilant 897, Vigilant 889	Great Britain (1961, 1962), series production	Manual, wire-guided (dynamic)	14(6) / 25	1400 / 185—275	600 / 156	1070 / 110(280)	Mobile launchers, armored cars, helicopters (launcher tube is used as transport container)
Swingfire	Great Britain (1969), series production	Semiautomatic, wire-guided (swiveling nozzle)	36(7) / .	4000 / 150	530 / 185	1067 / 170(370)	Portable launchers, tanks, APC, armored cars, helicopters
T581 ENTAC	France (1960), series production; NATO countries (1961)	Manual, wire-guided (spoilers)	12(5) / 17	2000 / 400	500 / 85	830 / 150(370)	Portable launchers, launchers on trucks and APC (launcher serves as transport container)
Cobra 810B, Cobra 2000	FRG (1962, 1968), series production	Manual, wire-guided (spoilers)	10(2.5) / .	1600, 2000 / 400	500 / 85	950 / 100(480)	Portable launcher (can be mounted on vehicles)

Table 6.2.1 (cont'd)

1	2	3	4	5	6	7	8
Malcara Mk1A	Great Britain (1959), production terminated	Manual, wire-guided (aerodynamic)	97(27)/.	3200/450	500/130	1970/225(790)	Hornet, Humber twin launcher, M113 APC, twin launcher on M59 APC chassis, helicopters
		Second Generation					
Shillelagh Mk2	United States (1966), series production	Semiautomatic, with infrared command transmission link (jet nozzles)	27(6,2)/.	3000/200	600/287	1150/152(280)	M551 Sheridan and M60A2 tanks
Shillelagh Mk 3	United States	Semiautomatic, infrared communication channel	./.	4000/300	600/.	1150/152(280)	Same
TOW	United States (1968), series production; FRG (1971), purchase	Semiautomatic, infrared guidance channel	17(3,6)/91	3750/65	500/210	1140/148(415)	Portable launchers (tripod-mounted launcher), self-propelled launchers mounted on APC and trucks
Dragon	United States (1972), tests, preparation for production	Semiautomatic infrared, wire-guided (pulse jet)	6(2,5)/14,5	1000/30	430/110	650/123(320)	Portable launchers (launcher tube used as transport container)
SS-11B1	France (1965), series production; NATO countries	Semiautomatic infrared, wire-guided (aerodynamic)	29(6)/.	3000/350	600/190	1200/164(500)	Twin launchers on APC, trucks, helicopters, tanks
MILAN	France, FRG (1974)	Semiautomatic infrared, wire-guided (jet vanes)	6,6(2,9)/27	2000/25	500/200	769/130(260)	Launcher (tube-carrier container on mount) can be mounted on vehicles
HOT	France, FRG (1973)	Semiautomatic, infrared, wire-guided (jet vanes)	22(6)/.	4000/75	550/260	1270/132(310)	Launchers on APC, helicopters, tanks, ICV

Table 6.2.1 (cont'd)

1	2	3	4	5	6	7	8
		Experimental ATGM and In Development (Third Generation)					
Atlas	Great Britain and Belgium (Experimental)	Semiactive head, homing guidance with laser-illuminated target	./.	1000/15	400/220	./110	Portable launcher
Acra	France (1975)	Semiautomatic, laser beam (aerodynamic)	24(7)/.	3300/25	600/520	1200/142(130)	AMX-63 tank, AMX-10C APC
Mamba	FRG	Manual, wire-guided (spoilers)	11.2/.	2000/300	500/140	995/(400)	Launch gear same as Cobra ATGM
Mystic	United States	Semiautomatic, with homing guidance head and laser illumination of target	11.2/.	6000/.	500/.	995/152(177)	Portable launcher
LASH	United States	Semiautomatic, laser guidance	./.	1500/25	500/550	more than 300	AMX-63 tank, APC
Sparviero	Italy	Semiautomatic, infrared beam	./.	4000/75	./290	./130	Portable launcher
Diano	Italy	Semiautomatic, radio	./.	3500/75	500/475	./.	Portable launcher
Polecat	United States	Semiautomatic, homing guidance, infrared target illumination	./.	1830/.	./.	./120	Antitank or recoilless gun
Hornet	United States	Semiautomatic, homing, laser target illumination	./.	./.	./.	./177.8	Same
Hellfire	United States	Semiactive laser	27.2/.	5500/.	./.	1500/152	Helicopters

At the present time there is observed abroad a trend toward decreasing the weight of ATGM and toward their miniaturization. For example, while the earliest ATGM, such as the Malcara, SS-12 and others weighed between 75 and 100 kg, the weight of modern ATGM in service and under development will be 6-30 kg (Dragon, TOW, ACRA). In connection with a decrease in weight, there has also been a decrease in the size of antitank guided missiles. This has led to the employment of a large number of ATGM on launchers mounted on trucks, armored personnel carriers, tanks, fixed-wing and rotary-wing aircraft. The foreign press notes a trend toward increase in the ATGM basic load of ammunition in antitank subunits.

There is a trend toward increasing the flight speed of ATGM, since it is obvious to everybody that the greater a projectile's speed, the less time a tank has to maneuver and take shelter behind terrain irregularities or local features, and therefore the greater its vulnerability. An analysis indicates that while the majority of antitank guided missiles presently in service and in production travel at a maximum speed of 80-85 m/s (SS-10, ENTAC, Cobra 810B, Cobra 2000, MAT, Bantam) or range between 110 and 260 mps (SS-11, Dragon, Vigilant, Malcara), second-generation missiles in production or under development have a maximum speed of 270-650 mps (Swingfire, HOT, ACRA, Mosquito). One should bear in mind that knowledge of range of fire against tanks is acquiring great significance for developing tank tactics in conditions of enemy employment of ATGM.

We know that two ranges are specified with ATGM: minimum and maximum. Minimum range is the distance from the ATGM launcher to the point where a fired missile becomes guided. Maximum range is the range of missile flight during which it remains guided. For the majority of ATGM in service, minimum range varies from 300 to 500 meters, and maximum range from 1,500 to 4,000 meters. Some foreign ATGM, however, have a minimum range of 25-200 meters and a maximum range up to 6,000 meters (SS-12).

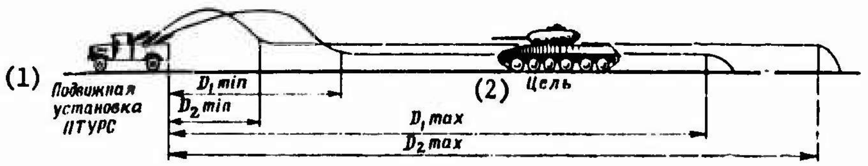

Figure 6.2.1. ATGM Minimum and Maximum Range of Fire

Key:

1. Mobile ATGM launcher
2. Target

D_1 -- First generation
D_2 -- Second generation

As is evident from Figure 6.2.1, at minimum range a missile is not yet guided and a tank enters a "dead" zone, as it were, in which it cannot be hit. Foreign military experts believe that this circumstance should be taken into consideration in developing tactics for tanks attacking ATGM positions. Tanks, taking advantage of terrain irregularities and local features, should get into the ATGM "dead" zone as quickly as possible and from this zone destroy the antitank guided missile positions with their fire or tracks.

The foreign military press notes that the commencement of a missile's guided flight depends in large measure on the skill and ability of the firer (operator): the less well-trained the firer (operator), the larger the ATGM "dead" zone will be.*

It is also noted that knowledge of the maximum range of ATGM enables one correctly to select tank deployment lines beyond the zone of effective ATGM fire. In those cases where terrain is flat and open, according to foreign sources, it is recommended that the tank deployment line be specified not closer than the maximum range of ATGM fire.

Saturation of combat formations with ATGM, as well as their improvement and provision of the capability of firing ATGM from man-portable and mobile launchers, have substantially complicated tank actions on the battlefield.

We know that ATGM in service with NATO armies are launched from ground or mobile launchers, including tanks, armored personnel carriers, infantry combat vehicles, fixed-wing and rotary-wing aircraft. Missiles are fired either directly from their transport containers or from special launching devices with guides and mounted on vehicles. Figure 6.2.2 and 6.2.3 show methods of launching ATGM.

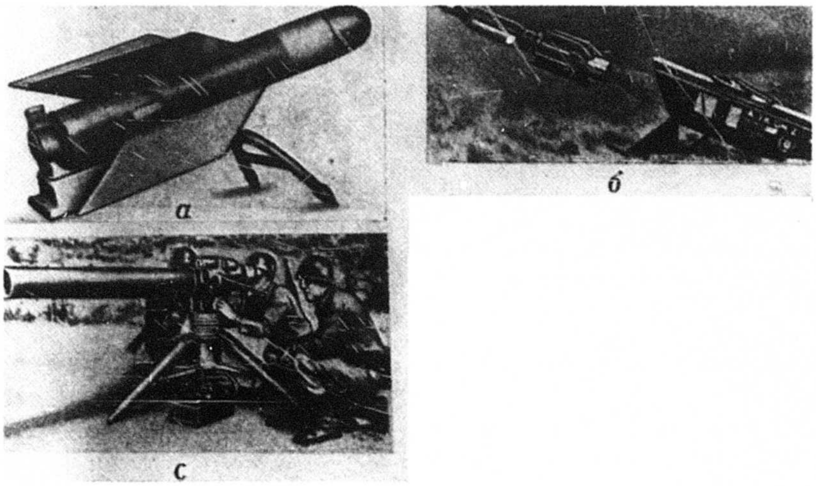

Figure 6.2.2. Methods of Launching ATGM from Stationary Ground Launchers:

a -- from ground launcher; b -- from transport container; c -- from launch tube

The majority of new ATGM presently on the drawing board are to be fired from a tube mounted on a special tripod. A missile can also be fired from a shoulder-held tube (MILAN, HOT, TOW). Foreign military experts believe that knowledge of missile guidance systems is acquiring great importance for development of tactics of combating ATGM. Basically there can be many different systems of guiding ATGM to the target. At the present time, however, following are the principal missile guidance systems employed in the armies of capitalist countries**:

* See REVUE MILITAIRE GENERALE, July 1972.

** See TRUPPENDIENST, May-June 1972; REVUE MILITAIRE GENERALE, July 1972.

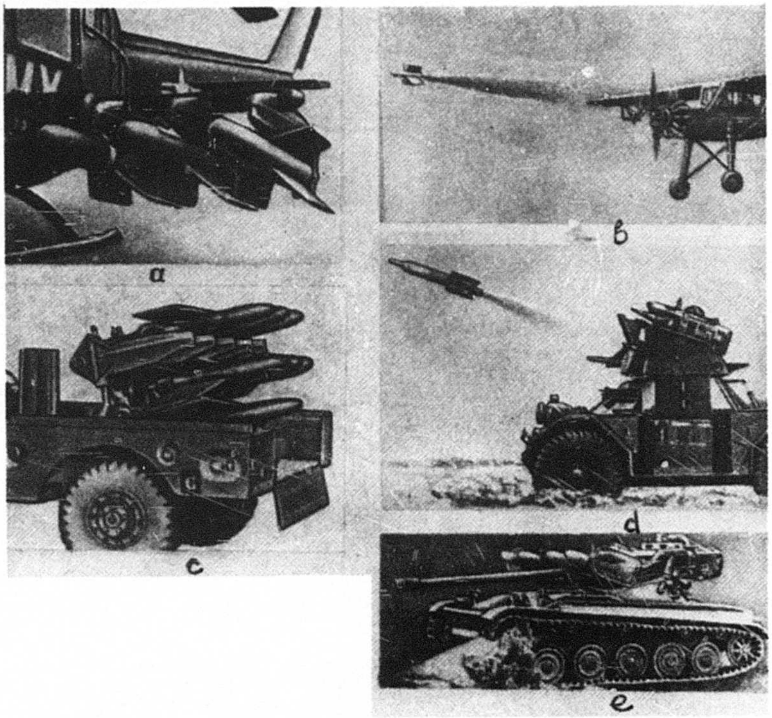

Figure 6.2.3. Methods of Launching ATGM from Mobile Launchers:

a -- from helicopter; b -- from fixed-wing aircraft; c -- from truck; d -- from armored personnel carrier; e -- from tank

a) manual -- remote control with commands transmitted by wire or radio;

b) semiautomatic or combination -- wire guidance plus homing head employing infrared or UHF beams, as well as laser beam;

c) self-contained or automatic.

It is pointed out that all guidance systems other than an automatic system involve manual guidance and require a controller (operator), who must guide the missile's flight, from launch to target impact.

In manual ATGM guidance systems (SS-10, SS-12, Vigilant, Swingfire, Cobra, Malcara), the operator must constantly track the target and the missile in flight and steer it into the target by means of a control device, with the aid of which commands are transmitted to the missile by wire or radio. The commands "Right," "Left," "Down," and "Up" are sent to the missile. Superimposing the target and missile onto a single point, the operator steers the missile to the target. Thus in manual or command guidance systems there are three communication links which can be affected in order to prevent a tank from being hit: the weapon-target line, the missile trajectory, and communication channels for transmitting commands from operator to missile (wires or radio channels).

It is noted that in combination or semiautomatic guidance systems (MILAN, HOT, Dragon, Shillelagh) the operator tracks only the target. The missile automatically tracks the operator-target line, seeks to go onto this line, and follows it into the target. In these systems there are only two communication links: operator-target line, and missile flight trajectory.

It is sufficient to exert effective influence on just one communication link in order to prevent a tank hit. Tankers should utilize precisely this in combating enemy ATGM.

In self-contained or automatic guidance systems, such as the Atlas, Mamba, and Hellfire ATGM, the missile guides itself to the target. Therefore these systems contain only one communication link which must be acted upon in order to complicate or prevent a target hit.

In order better to understand the mechanism of missile guidance to the target, we shall examine the semiautomatic guidance system employed by the French second-generation SS-11B1 ATGM.*

Figure 6.2.4 contains a block diagram of this missile's semiautomatic guidance system. It operates as follows. The operator spots a mobile armored target with the aid of an optical instrument which is rigidly connected to the infrared guidance system sensor and, holding the target in the instrument's crosshairs, fires the missile. The semiautomatic guidance system commences to function as soon as the missile is fired.

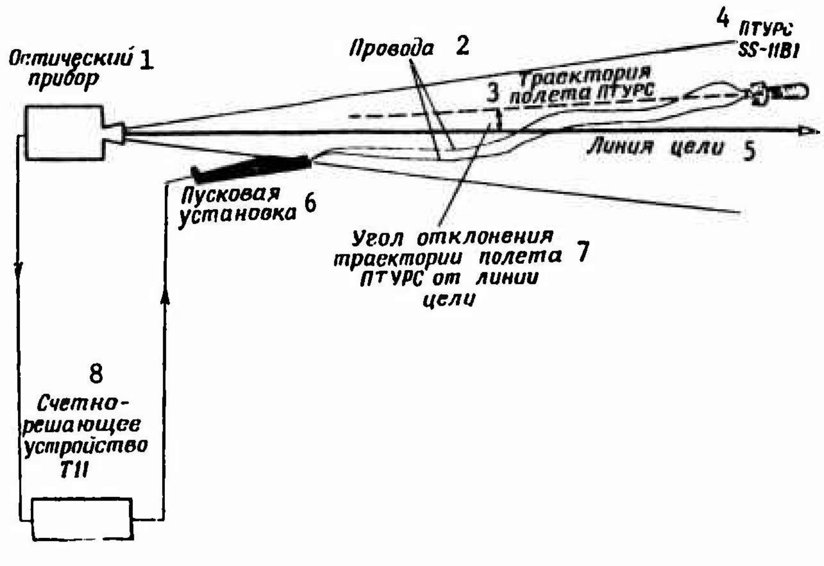

Figure 6.2.4. Block Diagram of a Semiautomatic ATGM Guidance System

Key:
1. Optical instrument 2. Wires

* See REVUE MILITAIRE GENERALE, July 1972.

Key to Figure 6.2.4 (cont'd)

3. ATGM trajectory
4. SS-11B1 ATGM
5. Operator-target line
6. Launcher
7. Angle of deviation of ATGM trajectory from operator-target line
8. T11 computer

The system's equipment, which detects the infrared radiation of the tracking flare on the missile in flight, automatically holds the missile on the operator-target line. If the missile deviates from the line to target, data on the deviation angle are fed into a computer (T11) hooked up to the launcher, and the computer generates appropriate commands in the form of electrical pulses transmitted by wire to the missile. These commands are transformed in the missile's onboard equipment into corresponding movement of the missile's controls, as a result of which it returns to the operator-target line.

Analysis of existing foreign guidance systems indicates that manual guidance of the missile to the target is essential in the majority of these systems. Many Western military experts note this as a shortcoming of ATGM. General [Zh. Marzloff], for example, notes in an article entitled "Combat Against Tanks"* that during firing of an ATGM the controller-operator must the entire time track either the target and missile simultaneously or just the target. If he loses sight of the target or missile for several seconds, the ATGM may go astray. This is a very important factor for organization of countermeasures against antitank guided missiles and, in the opinion of foreign military experts,** generates a number of attractive ideas for tank actions upon encountering an ATGM.

3. Methods of Tank Protection From and Countermeasures Against ATGM

In view of the combat capabilities of ATGM and a trend toward heavily saturating troop combat formations with them, tankers should consider them enemy number one and possess the skill of combating them effectively. This is possible if one knows their strong and weak points.

Foreign military experts consider the following to be the strong points of ATGM (Table 6.2.1):

capability to pierce the thickest armor which tanks can carry -- 400-650 mm;

versatile launch capability from ground and mobile launchers, including armored vehicles, fixed-wing and rotary-wing aircraft;

high battlefield maneuverability and simplicity of operation;

battlefield utilization capability against all targets;

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* See REVUE MILITAIRE GENERALE, July 1972.

** See TRUPPENPRAXIS, February 1977.

high moving target kill probability: 95 percent at maximum range, and 85 percent at minimum range.*

Foreign military experts note the following as weak points of ATGM**:

the necessity of continuously tracking target and missile with manual (command) guidance systems and only the target with semiautomatic guidance;

brief loss of the target from sight, which can result in the missile going astray;

considerable missile flight time to target;

increased number of missile guidance failures as the missile proper becomes more complex;

existence of a "dead" zone to a distance of 300-500 meters from the launcher.

Proceeding from an evaluation of the strong and weak points of ATGM, three modes of protection of tanks and countermeasures against ATGM are noted: group, individual, active, and passive.

With the group method of protecting tanks and countermeasures against ATGM, measures providing protection of the tanks of the entire attacking or defending subunit, as well as destroying or neutralizing hostile ATGM are conducted in a centralized manner, by orders of the senior commander.

One of the most effective group methods of protecting tanks from and countermeasures against ATGM is tank employment of tactics which make it difficult for the adversary to employ ATGM. Such tactics include utilization by tank subunits of terrain conditions (ravines, gullies, woods, copses, inhabited localities, standing crops, and brush) for closing with the enemy and simultaneous neutralization of ATGM launcher positions with artillery fire or airstrikes. The longer the time during which tanks remain unseen by enemy ATGM operators during closing to contact and assault, the greater the tanks' chances of survival.

Utilization by tanks of rough terrain covered by brush, sparse trees or local features can lead to premature detonation of ATGM if the warhead fuzes are set for instantaneous, or to loss of guidance as a consequence of breaking of command transmission wires from control box to missile. Figure 6.2.5 demonstrates the principle of utilization of terrain irregularities and local features for tanks closing with and neutralizing ATGM.

Neutralization of ATGM launcher positions with nuclear weapons, massed artillery fire and airstrikes, as well as fire delivered by the attacking tank subunits, as noted in the foreign military press, is also a group method of protecting tanks from and countermeasures against ATGM. It was noted above that in order to score a tank hit, ATGM controller-operators must continuously maintain visual contact

* ZARUBEZHNOYE VOYENNOYE OBOZRENIYE, Moscow, No 9, 1978.
** See ORDNANCE, September-October 1972.

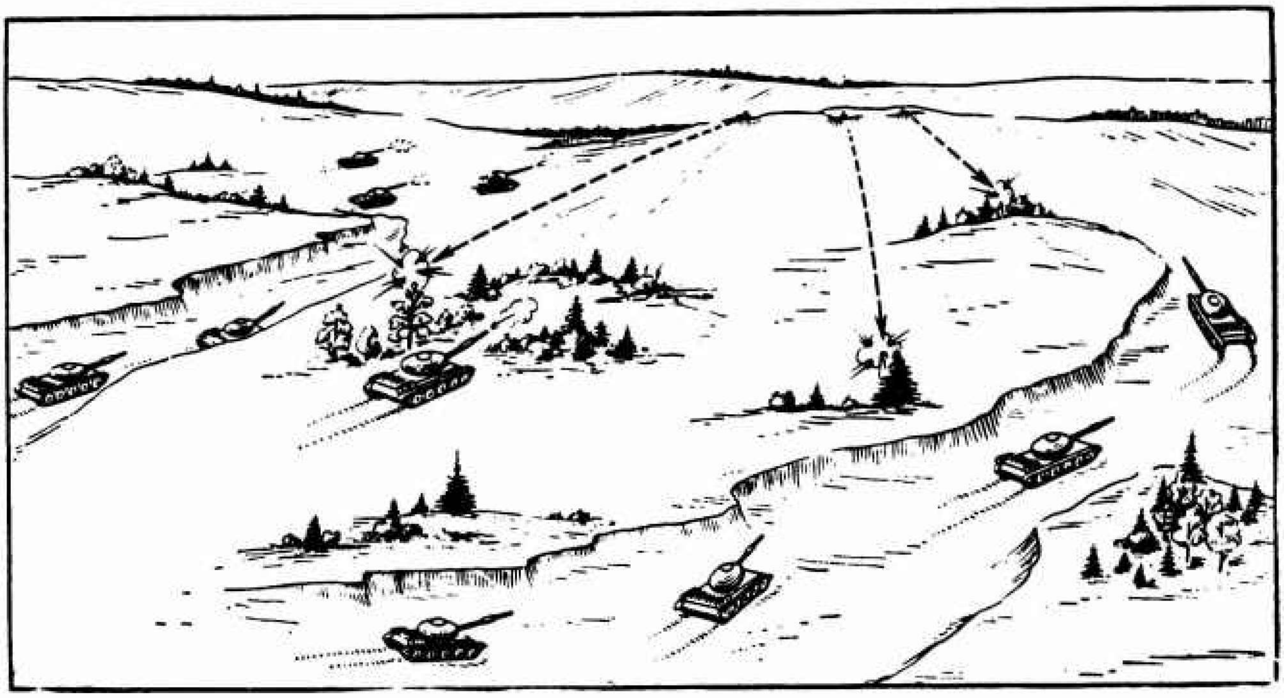

Figure 6.2.5. Utilization of Terrain Irregularities and Local Features for Tanks to Advance to and Attack an ATGM Launcher Position

with the target in their guidance instruments. If the tracker turns his head away for a few seconds, he will lose the missile. Nuclear bursts as well as air-strikes, and heavy artillery and mortar fire will force operators to seek brief shelter, and consequently lose their target (Figure 6.2.6).

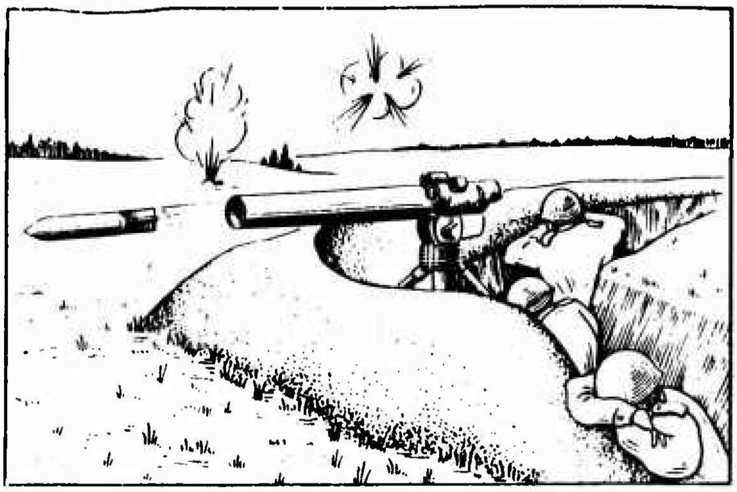

Figure 6.2.6. Artillery Fire and Airstrike Countermeasures Against ATGM

Many foreign theorists believe that laying down smoke screens by aircraft, with the aid of artillery and the tanks themselves, also constitute a means of group protection of tanks. The appearance of a solid or limited-area smoke screen forward of ATGM launcher positions will cause controller-operators to lose sight of the targets, and consequently lose their missiles as well. Employment of smoke screens on open terrain with sparse vegetation will be one of the principal means of group protection of tanks. Figure 6.2.7 shows a method of group protection of tanks by laying smoke screens. Smoke screens can be employed, however, only in conditions where the wind is blowing in the direction of enemy ATGM positions or at a certain angle to them.

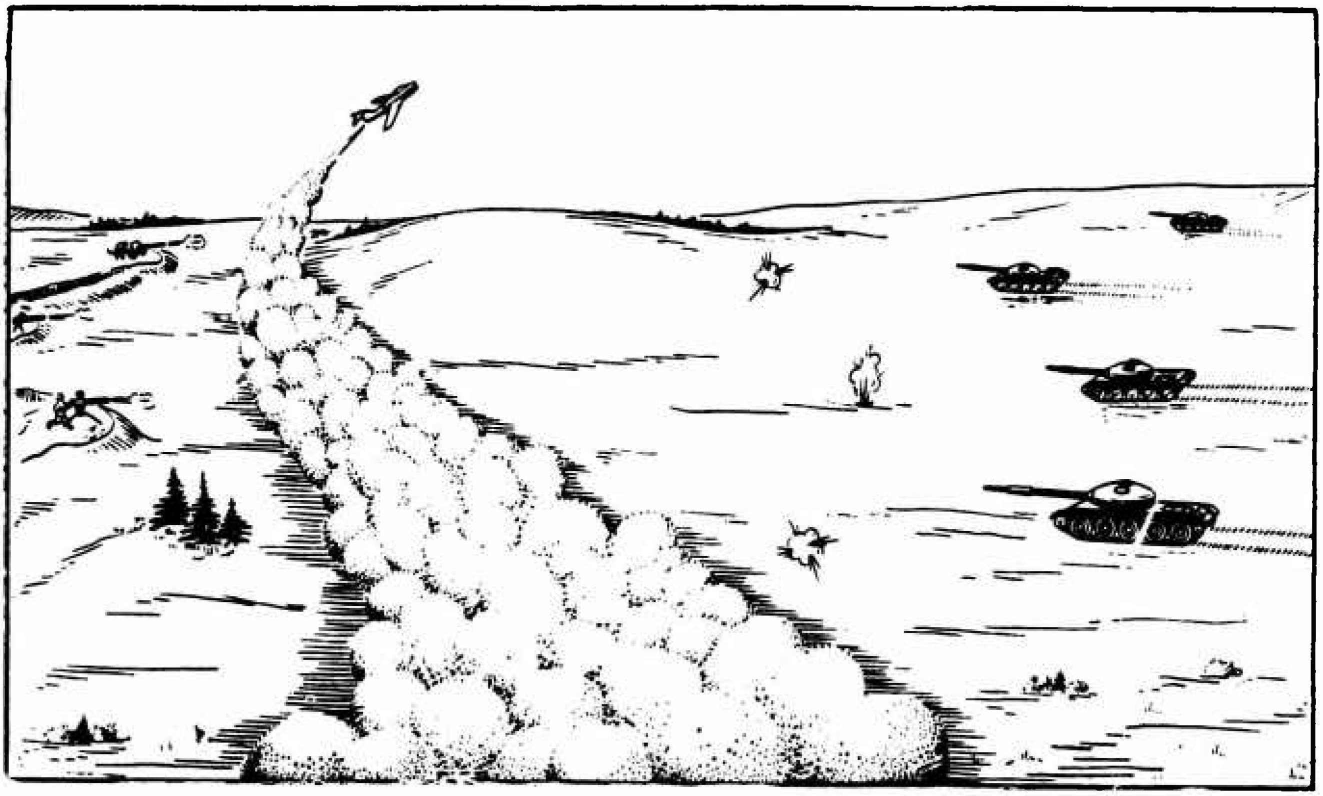

Figure 6.2.7. Method of Group Protection of Tanks From ATGM Fire by Laying a Smoke Screen

The opinion is expressed in the foreign press that jamming radio command missile guidance systems and employment of decoy targets to fool homing-guidance missiles can be a group method of protecting tanks from and countermeasures against ATGM.*

The opinion is also expressed, however, that with properly organized ATGM radio command guidance, jamming is extremely difficult. For example, the controls of second and third-generation ATGM (TOW, MILAN, HOT, ACRA, Hellfire) can operate in the 1-meter, decimeter, and centimeter bands. Therefore jamming must cover a

* See ORDNANCE, September-October 1972.

broad range of frequencies. And this requires radio and radar jamming transmitters with an output of not less than 250 kw. Such jammers can be carried on armored vehicles proceeding in the combat formations of tanks, or on board aircraft escorting the attacking tanks.

It is recommended that false radar targets be generated during a tank attack, which can also perform the role of group protection of tanks. False radar targets, such as corner and other reflectors, metal strips, etc, can be generated by specially assigned armored vehicles proceeding ahead of the attacking tanks, as well as from the air by fixed-wing and rotary-wing aircraft.

As regards homing missiles (ACRA, Mystic, Hellfire ATGM), in these instances it is recommended that one consider the fact that their homing heads commence operating fairly close to the target -- 100-150 m. And this means that there will be very little time available for jamming such missiles, and therefore protective measures must be undertaken by bounds, in a centralized manner, in the course of the attack. Foreign experts consider passive protection measures to include scattering of napalm flame generators or extended-flight flares by patrol and reconnaissance tanks or with the aid of fixed-wing and rotary-wing aircraft on lines which tanks will be crossing, as well as utilization of special tanks to generate protective smoke screens forward and on the flanks of attacking tanks.

Stated in the foreign military literature is the idea of employing powerful searchlights to generate infrared screens forward and on the flanks of attacking tanks to protect them against ATGM with infrared heat-seeking heads. It is believed that employment of such searchlights can be very effective.

With the individual mode of protection and countermeasures, each tank protects itself and conducts countermeasures against hostile ATGM independently. Each tank crew performs various measures, which foreign experts list as follows: employment of smoke shells, generators and bombs by individual tanks; camouflage and concealment of combat vehicles, utilization of active tank protection by destroying ATGM in the field, as well as increasing tank armor resistance to shaped-charge warheads in order to reduce the effect of ATGM on an armored vehicle. Efforts to increase armor resistance are being conducted in many countries.* Problems of resistance of armored hulls have been studied since the appearance of antitank artillery. Armor resistance to shaped-charge warheads, however, did not begin to be examined until the development of shaped charges. Armor resistance to shaped-charge warheads can be achieved, on the MBT 70 tank, for example, by developing composite armor which can withstand high specific pressures and high temperatures. Since a shaped-charge jet burns through armor, heat-resisting components are employed in composite armor, and skirting plates are employed to ensure armor resistance to shaped-charge warheads. Skirting plates can vary (thin armor plates and metal screens mounted on the tank hull, etc). In Great Britain and the FRG, for example, armor plates are extensively employed as tank skirting plates.** For example, turret skirting plates, etc can be installed.

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* See J. Polk, "We Need a New Tank," ARMOR, July-August 1972.
** See [B. Dyunets], "Tank Gun or Guided Missile?" ORDNANCE, September-October 1972.

The purpose of employing skirting plates is to cause a shaped charge to burst prematurely, putting the tank's main armor beyond the focal point of the shaped-charge jet, where the pressure and temperature of the jet reach a maximum.*

Many foreign military experts believe that tank camouflage and concealment promotes their individual protection. Employment of camouflage makes a tank inconspicuous against the terrain background and thus makes it more difficult to detect and observe when firing an ATGM. In addition, employment of antiradar coatings on tank armor (M60A1) supposedly makes them little vulnerable to radar-homing missiles. This coating, applied under camouflage, makes visual and radar detection of tanks difficult.

Foreign experts also express the opinion that infrared camouflage is an important individual means of protecting tanks against missiles with infrared homing guidance. Armored vehicle infrared camouflage measures reduce the quantity of heat given off by an armored vehicle to the environment, and thus reduce the sensitivity of ATGM heat-seeking missiles. This, in the opinion of foreign military experts, makes difficult tank detection by antitank guided missiles, and homing guidance heads capture the target at close range, as a consequence of which ATGM will frequently overshoot the target. Displacing the thermal center to one side or above a vehicle may be an important means of individual protection of tanks against ATGM.** The displacement point should radiate considerable heat and offer a target to heat-seeking ATGM. The missile may hit only the heat release point, leaving the tank unharmed.

Finally, foreign military engineers believe that individual active protection of tanks by destroying ATGM on approach to the tank may be another significant measure.

In past wars shrapnel and canister shot development in artillery was no mere happenstance. If it was necessary to hit enemy infantry and cavalry close to friendly troops, canister shot or grapeshot was employed, while shrapnel was employed if this was to be accomplished at a distance from artillery positions. It is believed that this idea can also be successfully utilized for organizing countermeasures against antitank guided missiles as they approach tanks.

Western experts note that such individual means of active tank protection should include means of prompt and timely detection of hostile ATGM and should operate as self-contained automated systems. Without going into cost, but taking account of advances in radioelectronics and mechanics, they claim that such active means of individual tank protection can be developed.

We have examined above the group and individual modes of protecting tanks and countermeasures against ATGM, which differ in organization and extent of measures conducted. Both these modes in turn, however, can be active or passive in protection and countermeasures.***

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* See ARMOR, July-August 1972.

** See H. Wein, "Antitank Defense at Night," TRUPPENDIENST, May-June 1972.

***See REVUE MILITAIRE GENERALE, July 1972; ARMOR, July-August 1972.

Active mode of protection and countermeasures is defined as neutralization and destruction of ATGM at principal launcher positions by airstrikes, artillery and tank fire, as well as by nuclear weapons, actively jamming ATGM guidance systems, and destroying ATGM during flight to the target with the aid of tank auxiliary or main armament.

Passive modes of protection are defined as those which diminish the effectiveness of ATGM. They include the following, according to data in the foreign press: employment of concealing or obscuring smoke screens, skirting plates and composite armor on tanks, and false targets to confuse homing-guidance missiles.

In conclusion we can state that the development of such antipodes as the tank and antitank missile once again confirms manifestation of the law of unity of opposites in military affairs. Improvement of modern tanks resulted in the development of antitank guided missiles, which in turn led to a new stage in improvement of tanks and development of new methods of their employment and countermeasures against ATGM. Therefore there are no objective grounds to claim the decline of tank troops and that the tank has become obsolete on the battlefield.

Extensively employing modes of group and individual protection and countermeasures against ATGM, tank troops can successfully operate on the battlefields and maintain their predominance. As foreign military experts believe, the tank will continue operating effectively on the battlefield for a long time to come and will constitute one of the principal factors in achieving victory in nuclear war. Therefore one of the principal tasks of tank officers and combined-arms commanders is the search for methods of tank operations in the war of today, in which battlefields will be saturated by all types of antitank weapons.

Chapter 3. MOVEMENT OF TANK TROOPS

1. Contemporary Warfare and Space

The entire history of the art of warfare constitutes a continuous process of evolution of the means and modes of waging war. Weapons and other military equipment have changed and improved, and the modes of waging war have correspondingly changed. Development of modes of conduct of combat operations was accompanied by an increase in the spatial scope of the battlefield and war as a whole.

If we trace the process of growth of the spatial dimensions of combat operations, we can establish a definite pattern, which consists in the following: the dimensions of the battlefield and war as a whole have increased proportionately to increase in the power and range of weapons and increase in the maneuver capabilities of armed forces. In other words, the greater the quantity of manpower and weapons, the better their performance characteristics (range, casualty effects, mobility), the larger the territory required for waging combat. The scale of maneuver of troops increases in connection with this, the conditions of their movement become more complex, and the character of maneuver changes.

Up to and including the 19th century, wars were restricted to that territory on which combat operations were directly conducted. The area over which a battle took place was easily observable from a single command post.

Adoption in the military of mass quantities of new weapons, which provided a sharp increase in volume of fire and troop maneuver capabilities, led to a situation where by World War I the framework of combat operations had greatly expanded, continuous fronts had appeared, and substantial territory adjacent to the battle line was now part of the area of military operations.

The spatial scale of areas of combat operations increased to an even greater extent in World War II. Battles were fought along gigantic continuous fronts, and the combat zone included substantial areas located deep within the territories of the belligerent nations.

The process of increase in the spatial scale of engagements and operations was accompanied by change in the scale of troop movements. The larger the combat zone became, the more frequently there occurred the need to improve tactical and operational maneuvers for the sake of gaining victory over the adversary. Simultaneously with this there occurred an increase in the role and significance of troop movements and depth of maneuver. Achievement of success in any engagement and operation was becoming increasingly dependent on quickness of troop maneuver.

Experience indicates that whoever skillfully utilized capability to execute broad maneuver of men and weapons for the purpose of achieving superiority in manpower and weapons on a decisive axis, invariably secured the conditions for achieving victory. In February 1944, for example, the German-fascist command was attempting to rescue the troops of the encircled Korsun'-Shevchenkovskiy force by mounting an attack with substantial forces in the vicinity of Lisyanka, but this attempt proved fruitless. Following a skillfully executed maneuver, the III and XVI Tank Corps and the XI Guards Tank Corps reached the threatened sector in a timely manner and mounted a powerful attack on the enemy.

In the past war tank troops very frequently shifted position both within the boundaries of a battlefield and outside combat zones. These movements accounted for approximately 60 percent of their total time of combat operations.

The role of movements will become even more important in a future war. The highly mobile character of combat operations, the possibility of mass casualties and the necessity of rapidly building up the efforts of forward-echelon troops, increased capabilities of the adversary to disrupt troop movements by rail, as well as increased march capabilities of tank troops -- all this can result in a large portion of combat activities of tank troops consisting in movement in march formation. It is also claimed that the depth of movement of tank troops by their own transport resources will increase.

In the past war, in spite of the fact that combat operations were conducted over vast territories, a theater of war could be arbitrarily divided into the area in which combat operations were being conducted and an area which was relatively calm and in which the occurrence of war was indicated only by indirect signs. In these conditions tank and mechanized troops, when moving large distances, could travel by rail right up to the zone immediately adjacent to the front. Air power was unable to break up rail traffic deep in the rear. Therefore tank and mechanized troops unloading areas were frequently 150-200 km or even less from the line contact. After unloading from trains, tank units and combined units as a rule had sufficient time to become fully combat ready and for thorough organization of movement and comprehensive preparation for forthcoming combat operations.

It is true that in the course of World War II there were cases where tank and mechanized troops were forced to cover great distances as well under their own power. In July 1943, for example, the IV Guards Tank Corps successfully executed a march from the vicinity of Zemlyansk to the Oboyan' area, a length of 450 km, while in August 1944 the IV Guards Mechanized Corps traveled a distance of 600 km, from Dorobyantsu to Burgas.

It is noted in the foreign military press that under conditions of combat operations with employment of nuclear weapons, weapons are capable of surmounting any obstacles within minutes and of delivering a devastating attack on any target, at any distance. Consequently the most important rail and highway junctions, bridges, dams, as well as airfields and seaports may be subjected to nuclear attack and be put out of commission for an extended period of time. This nature of physical destruction on lines of communication limits possibilities of moving troops by rail or water transport. Therefore under these conditions tank troops will most frequently travel even large distances under their own power.

It is believed that the character of movement will also change to a significant degree. In the past troops, when executing a movement, were subjected to hostile countermeasures only in the immediate vicinity of the battle line, as well as on the battlefield when they would move for the purpose of taking a more advantageous position or line in relation to the adversary. In most cases conditions of troop movement outside the contact area essentially differed in no way from peacetime conditions.

In the future, as indicated in the foreign press, conditions of movement will be incomparably more complex. Troops and lines of communication at any distance from the front may be subjected to attack by offensive nuclear weapons, aircraft, airborne assault troops and reconnaissance-raiding parties, and therefore any march becomes a complex combat mission, even outside the combat zone and at a great distance from the enemy. Enemy reconnaissance-raiding parties, armed with modern weapons, can inflict heavy casualties on advancing troops and create considerable difficulties as they move forward.

Now, it is claimed in the foreign press, it will be necessary for troops to expend significant efforts on the march to maintain their combat efficiency, to negotiate obstacles, as well as to combat hostile aircraft, various enemy raiding parties and assault forces. In addition, tank troop movements can be accomplished at any time of the year, day and night, in any weather, and on various terrain, frequently off roads.

Thus the conclusion is reached that modern conditions of combat operations require of tank troops the ability to travel long distances, at high speeds, and to arrive in the destination area on schedule, at full strength, and maintaining full readiness to engage.

2. Modes of Travel. Long-Distance Marches

Under present-day conditions tank troops may travel under their own power (that is, by march), rail and water transport, and combined mode, with simultaneous or sequential utilization of two or several modes of transport.

Selection of mode of troop transport is influenced by various factors: objective, scale, depth of movement, time allocated for its execution, status of lines of communication, availability and capability of means of transportation, condition of routes of movement, and character of enemy activities.

Movement of tank troops under their own power. As is noted in the foreign press, this type of movement is of particular significance, since it corresponds to the greatest degree to the demands and conditions of modern warfare. It is believed that travel by tank troops under their own power has a number of advantages in comparison with other modes of travel. First of all, a march ensures achieving a high rate of movement. It is apparent from the following graph (Figure 6.3.1), prepared on the basis of data in the foreign press pertaining to a U.S. Army armored division and a FRG Army tank division, that rail transport of troops provides a time savings in comparison with movement under their own power only when traveling a distance of 2,000 km. In their opinion, the advantages of tank troops traveling under their own power are not limited merely to achieving a high rate of movement. Of primary significance under present-day conditions is securement of the organizational integrity of subunits, and their constant readiness to perform combat missions at all stages of movement. Today this requirement evidently can be met with troops traveling under their own power. In addition, when executing a march under their own power, tank troops have better capability to maneuver for the purpose of crossing or bypassing zones of physical destruction and radioactive contamination, and also possess relative independence of large stationary installations on lines of communication, which can be destroyed by the enemy.

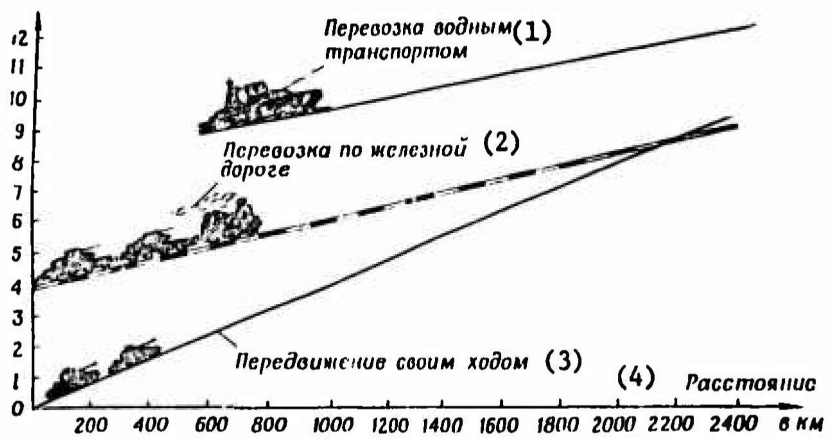

Figure 6.3.1. Graph of Time Expenditures When an Armored Division Travels by Various Modes

Key:

1. Travel by water transport
2. Travel by rail
3. Travel under own power
4. Distance

Let us see what march capabilities are possessed by tank troops. The principal indicators characterizing the march capabilities of troops are average rate of movement, vehicle range on one fueling, motor capacity, and tracks. March capabilities depend on proficiency of driver personnel, ability of commanders to lead columns, state of equipment, routes, and weather.

We know that the average rate of movement of troops depends primarily on the maneuver and operational characteristics of combat and transport vehicles. During the Great Patriotic War tank units and combined units, equipped with T-34 tanks, executed marches at an average speed of 20-25 km/h. In September 1944, for example, the V Guards Tank Corps traveled at an average of 20-25 km/h for a distance of more than 300 km. Today's tanks boast better performance, and therefore the average rate of movement of tank troops today can be greater.

The rate of movement of columns, and consequently troop march capabilities are significantly affected by the level of proficiency of driver personnel. For example, top proficiency-rated drivers can drive the same vehicles, under identical conditions, at an average speed of 25-30 percent greater than drivers of the lowest proficiency rating.

The physical capabilities of personnel are also of great importance. It is believed abroad that 12-14 hours at the controls can be a normal daily work load for drivers. Of the remaining hours in the day, drivers should spend 5-6 hours resting, 1.5-4 hours taking meals, and approximately 3-4 hours servicing their tank. Proceeding from this calculation and allowable average speeds, tank columns, in the opinion of U.S. military experts, can cover a distance of 300 km in a 24-hour period.

Tank range on one fueling, by motor capacity and tracks is an important factor which influences troop march capabilities. Range on one fueling for today's principal foreign tanks (M60A1, Leopard 2, AMX-30, Sheridan) can be approximately 500 km on one fueling, 6,500 km or more by motor capacity, and up to 8,000 km for tracks.

It follows from the above that modern tank troops possess excellent march capabilities and are capable of executing marches of considerable distances at a rapid pace under complex situation conditions, while maintaining a high degree of combat readiness.

Tank troops travel by rail. In spite of the obvious advantages of traveling under their own power, in many instances tank troops, when traveling great distances, will employ another mode of travel -- travel by rail. This mode of transportation makes it possible quickly and more economically to accomplish the mission of moving large masses of troops. Combat vehicles do not run up mileage, less personnel energy is expended, and troops can travel at high speed in all weather. But this mode of travel also has drawbacks. The most important is the fact that the organizational integrity of subunits and units is disrupted. In addition, units stretch out to considerable depth, because of which, after the first trains arrive in the new area, troops require a certain amount of time to reach a battleworthy state. As is noted in the foreign press, another serious drawback is the fact that man-made structures on rail lines are vulnerable to attack by nuclear missile weapons, airstrikes, and attacks by enemy raiding-reconnaissance parties.

Capabilities to move tank troops by rail transport depend primarily on speed of loading and off-loading, speed of trains, rail line traffic capacity, and availability of loading areas and rolling stock.

During World War II, when moving tank units by rail in the European countries, the rate of movement of trains amounted to 300-500 km per day. In the summer of 1944, for example, during movement by rail of units of the German-fascist 9th and 10th Panzer divisions from Poland to Nancy, trains traveled at a rate of more than 400 km per day.

Under present-day conditions, in connection with further development and improvement of the rail network, as well as upgrading of rolling stock, including motive power, train speeds have increased. Foreign military experts recommend that these capabilities be utilized in a period of conduct of combat operations without employment of nuclear weapons, and in a number of instances even with employment of nuclear weapons, although the traffic capacity of rail lines may sharply decrease.

Carrying tank troops by water transport. This mode is employed chiefly in transporting troops from one theater to another. Transporting tank troops in coastal sectors will obviously involve considerable difficulties which, according to data in the foreign press, consist primarily in the following.

Under present-day conditions large numbers of ships will be required to transport tank troops by water. According to figures in the foreign press, for example, more than 20 large transports are required to move one armored division. It is believed that it will be difficult to assign such a large number of transports, since with the outbreak of hostilities means of transportation at the disposal of the military will be utilized on a priority basis for delivering amphibious landing forces. As combat experience indicates, this will require a large number of ships. In the amphibious landing operation in Korea in September 1950, for example, the Americans employed a total of 250 warships and vessels to land a reinforced Marine division and an infantry division (a total of 40,000 men).

Another difficulty lies in the fact that special cargo handling equipment is required for loading and off-loading tanks and other heavy equipment, which will be in short supply with mass shipping of men and equipment and if port facilities are damaged by attack. As a consequence of this, loading and off-loading of tank troops will require considerable time. In addition, it will be necessary to assign certain naval and air forces to escort a convoy of transports to the destinations, diversion of which to perform secondary missions is undesirable.

Foreign military experts reach a conclusion from all this that water transport cannot be widely employed at the present time for transporting tank troops in coastal sectors.

The situation may change in the future, however. Foreign military leaders attach great importance to construction of large tank landing ships. Such vessels make it possible to load and off-load personnel and equipment from an unequipped shore, substantially reducing loading and off-loading time. In connection with this, capabilities to move tank troops by water transport are increased.

3. Organization of March and March Support

It is believed that timely and comprehensive preparation for movement predetermines the success of a march to a significant degree. In order for tank troops to be able to utilize in full measure all their maneuver capabilities, comprehensive

preparation for and organization of a march are essential, which will require a certain amount of time. At the same time, under present-day conditions it will obviously often be necessary to organize movement of troops on a tight timetable. Control agencies may be faced with the necessity of accomplishing several tasks simultaneously: making troops combat ready, restoring their battleworthiness, as well as other measures. This will require of commanders and staffs a high degree of organization and work efficiency. Only under this condition will there be created guarantees that all requisite measures pertaining to preparing for movement will be accomplished on a tight timetable.

A high degree of organization and efficiency in the performance of control agencies in organizing troop movements can be achieved as a result of application of the most expedient, scientifically substantiated methods of decision-making and movement planning. Only with correct methods is it possible to guarantee the performance of control agencies and to reduce their work to a specific system, to ensure efficient sequential and parallel work by several echelons.

The conditions under which preparation for travel takes place can be quite diversified, and therefore one must assume that the work methods of control agencies will also be diversified. Certain general principles, however, are characteristic of this work.

Combat experience has shown that in conditions where there is inadequate time for organizing troop movement, staffs usually employ approximately the following method.

Upon receiving a task assignment, the commander studied it together with his closest aides. Parallel with this, the mission was marked on a map. Following mission briefing, those items were determined which had to be handled without delay. First of all the matter of organization of reconnaissance and security was determined, as well as traffic control service.

Then the main decision items (depth of march, routes, march formation, start point and start point passage time by heads of columns) were determined on the basis of a concise estimate of the principal situation elements and consolidated calculations. In order to reduce decision-making time, reference figures prepared in advance by the staff were utilized, particularly such data as quantity and status of weapons and equipment, quantity of supplies available, and calculations for movement in several variants (depending on the march formation, road and other situation conditions).

Warning orders would be issued on the basis of the march plan, indicating length of march, routes, and start point passage time.

After this the commander and his aides would calculate the march in detail, determine time of troop passage of control points and arrival in the destination area (if not specified by the higher command echelon), would work out matters of march support, would complete preparation of a road movement graph, and would draw up written combat documents. If the necessity arose, the commander would refine his decision.

This method shortens the time required to organize a march, since it makes it possible to organize parallel work at several echelons and promotes precise, purposeful efforts by all control agencies.

A march decision can be correct only when it takes into account the situation and requirements of forthcoming combat operations and is based on thorough, precise calculations. One should bear in mind that movement is not an end in itself; it creates favorable preconditions for accomplishing the principal mission, defeating the adversary in combat.

It is noted in the foreign press that under conditions of massive employment of modern weapons and highly mobile ground and airborne assault troops, the situation may change rapidly and abruptly in the course of a march. Therefore traveling subunits and units, even at a considerable distance from the line of contact, may be forced without warning to engage the enemy. On the basis of this, foreign military experts advance the demand that, when making his march decision, the commander should first of all determine a plan of action in case of an encounter with the enemy and should specify what grouping of forces should be secured in the designated area. These questions are obviously of determining significance for elaboration of other decision elements and, in particular, elements such as structure of the march formation, routes, movement support, etc. As is emphasized in the foreign military press, there does not exist a standard march formation. It depends on the presumed actions taken by the adversary, the assigned mission, existence and state of roads, weather conditions, and troop march capabilities.

In determining march formation one usually proceeds from the position that it ensure combat independence and stability of march columns against enemy weapons, freedom of maneuver and continuous readiness for rapid deployment into combat formation, optimal conditions for control, logistical support and maximum utilization of vehicle performance capabilities, preservation of combat equipment and conservation of energy of personnel, etc.

Not all these demands, however, are equally important in all circumstances. Depending on concrete conditions, sometimes one demand and at other times another demand is the most important. For example, in executing a march under conditions where direct encounter with the enemy is little probable, means of transport are utilized in the most efficient manner.

If tanks are executing a march when there is a threat of encountering hostile ground troops, the interests of conduct of combat against the enemy are paramount. Therefore it is recommended that the march formation ensure rapid dispersion of troops and prompt deployment into combat formations upon encountering the enemy, ensuring swift deployment and engagement without a halt in attack position.

Timely and organized movement of tank troops depends in large measure on precise planning. The essence of march planning consists in performing various calculations and in concrete determination of the sequence of troop actions during the movement, as well as in elaboration of comprehensive support measures. Of all the calculations performed by the staff, calculation of the march is the most complex and laborious.

March calculation for tank subunits and units executing a march with organic vehicles consists in distributing allocated time among movement, rest, messing, refueling, maintenance and inspection of equipment, as well as in determining the time the column will take to pass a given point, time of passage of the start point and control points, and time of arrival in the destination area. Fuel consumption is also determined in performing march calculations.

The principal demand on a troop movement calculation is accuracy, which is achieved by carefully taking account of all the conditions of the movement. Even minor errors in calculations can lead to serious consequences (to delay in reaching destination areas or deployment lines, to creation of traffic jams on roads and in front of obstacles, and to troop casualties at these locations).

As is noted in the foreign military press, initial data for march calculation usually include composition of troops, routes; number and length of march segments; time allocated for accomplishing the march; march formation; rate of movement of march columns on individual route segments; start point and traffic control points; areas and duration of halt (day's halt, night halts).

In order to reduce the time required to perform march calculations, such data as number of vehicles in subunits, march formation variants, column length, composition of reconnaissance agencies, march security, traffic control manpower and facilities obviously will be prepared by the staff in advance and be detailed when the mission is assigned. Various slide rules, tables, graphs, nomograms and other automation devices can be used to speed up calculations.

Figure 6.3.2 contains a nomogram (set up with logarithm scales) for determination of column length based on number of vehicles and vehicle lead, as well as time distance on the basis of road distance and rate of march.

It is convenient to utilize a scale rule to perform rough operational-tactical calculations (Figure 6.3.3).

The march plan is drawn up as a result of performed calculations, indicating all principal measures pertaining to troop movement. It is one of the principal planning documents.

Organization of movement under present-day conditions is not limited to reaching the commander's decision, formulation of missions, and planning the movement. Of great importance for successful execution of a march are measures pertaining to combat, special and rear services support of the march, the purpose of which is to provide the troops with conditions for successful accomplishment of the assigned tasks, to protect them from surprise air and ground attack, to maintain their fighting efficiency and to give them the opportunity promptly to execute dispersion or maneuver in order to bypass dangerous areas, successfully to accomplish a movement under any and all situation conditions, and to provide the troops with everything they need.

The inevitability of an abrupt situation change in the course of a march, increased capability to hit troops in movement, the great length of marches and high rate of march introduce, as is indicated in the foreign press, a number of specific

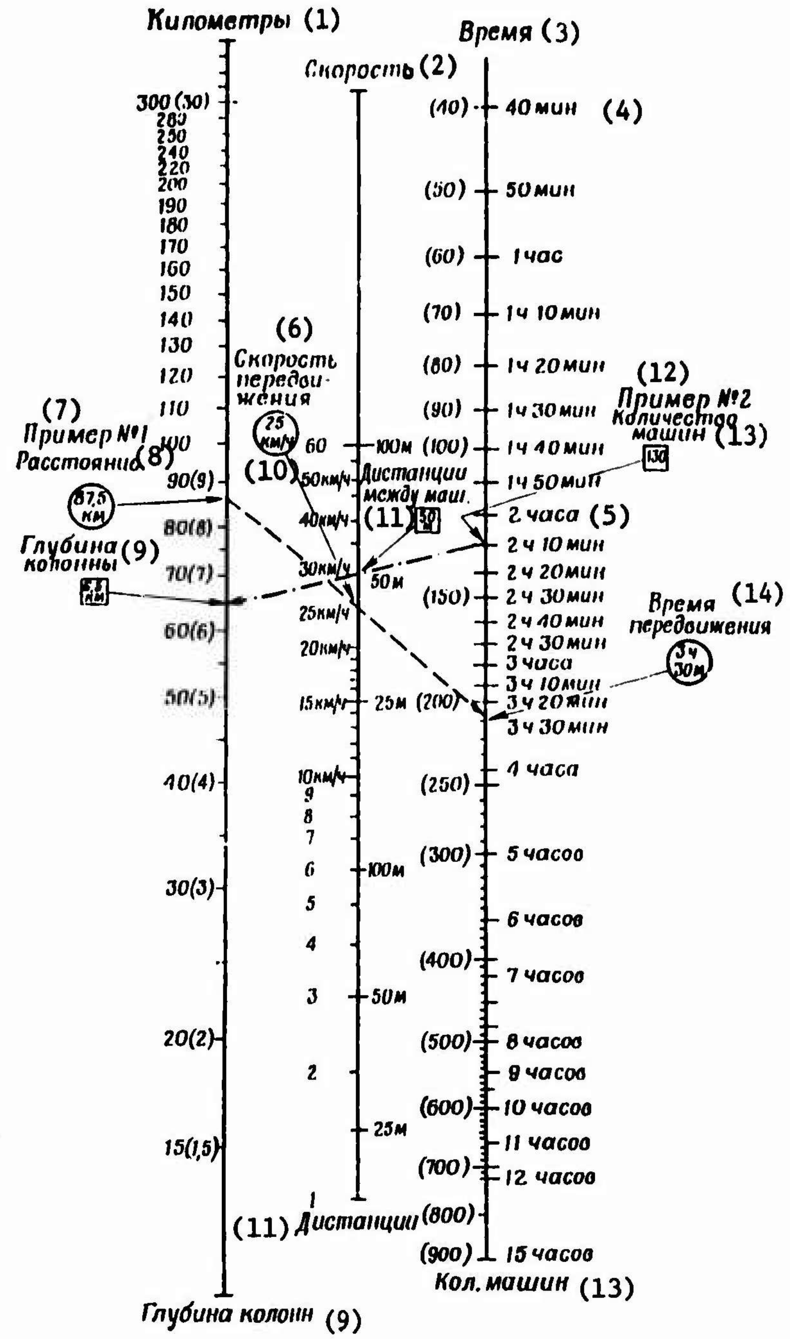

Figure 6.3.2. Nomogram for Determining Column Length and Time Distance

Key:

1. Kilometers	8. Road distance
2. Speed	9. Column length
3. Time	10. km/h
4. Minutes	11. Lead
5. Hours	12. Example 2
6. Rate of march	13. Number of vehicle
7. Example 1	14. Time distance

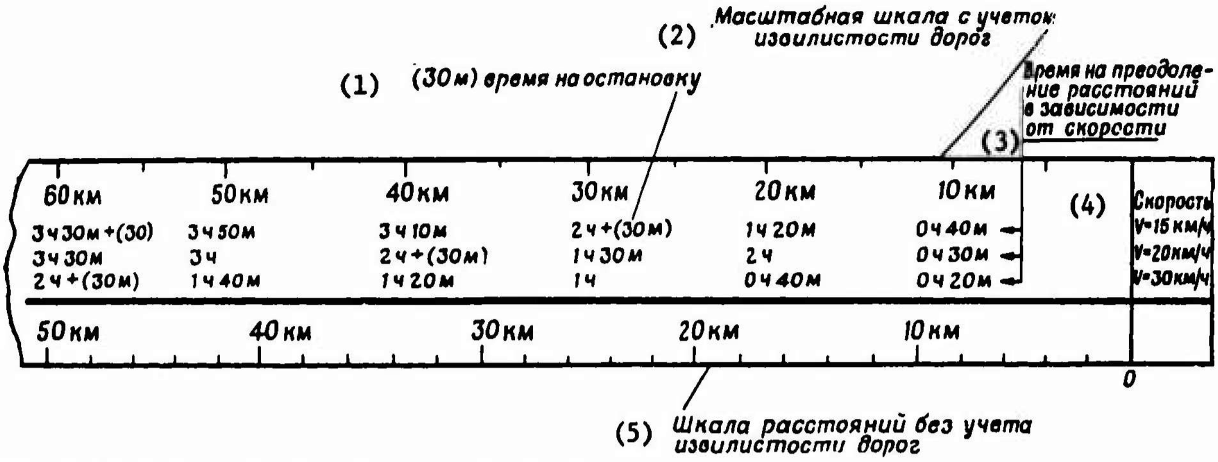

Figure 6.3.3. Rule for March Calculation

Key:

1. Halt time
2. Scale taking into account road twisting
3. Time distance in relation to speed
4. Speed
5. Scale of distances, without taking road twisting account

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features into the form and content of support. For example, at a considerable distance from hostile ground troops main efforts in the area of troop march support are focused on providing columns with cover against air attack, on providing security to roads, bridges, river crossings and the entire march formation against surprise attacks by various partisan forces. As a column approaches the front, march combat support is subordinated to the interests of engagement of the troops and creation of the most favorable conditions for deployment.

Due to the great number of measures pertaining to support as well as their complexity, they cannot be fully examined in this volume. Therefore we shall discuss below only certain aspects of security and traffic control.

Reconnaissance. In the opinion of foreign military experts, organization of reconnaissance during long-distance movements involves certain difficulties. This is due to the lack of situation clarity to the entire distance of the march and increase in the extent of missions performed by reconnaissance. In addition to normal missions of spotting the enemy, reconnaissance is assigned missions pertaining to determination of routes, degree of terrain trafficability off roads, and collection of information on the radiation and bacteriological (biological) situation along the route and in the troop concentration area.

The capabilities of troops en route to conduct reconnaissance are limited. This can be compensated to a certain degree by obtaining requisite information from higher headquarters and directly from air reconnaissance, and as the troops approach the front -- from units operating out ahead.

It is noted that intelligence obtained from these sources cannot fully satisfy the command when making the march decision, as a consequence of which it may become

necessary to supplement or refine the information obtained from higher headquarters. Reconnaissance subunits of the moving troops will perform these missions, concentrating their attention on obtaining information on those vehicles and installations which are of the greatest interest at this time. It is quite obvious that this will affect the composition of reconnaissance agencies, their place in the march and distance from the main forces.

Therefore when the mission is received, each route is reconnoitered, with a detailed study of the terrain (the state not only of the roads as a whole, but also individual stretches, condition of bridges, river crossing sites, etc), determination of potential areas of dropping (landing) airborne assault forces along the route of movement, spotting of obstacles and detection of contaminated areas, scouting out bypass routes around these areas, and detailed information on the radiation and biological situation.

As is noted in the foreign press, during execution of a march under conditions of absence of threat of encountering the enemy, reconnaissance teams on board helicopters are sent out in advance to reconnoiter routes, halt and rest areas, and to select control facility sites, as well as engineer reconnaissance patrols and traffic control subunits.

Sending out reconnaissance teams does not exclude detailing reconnaissance subunits for conducting ground reconnaissance, detailing the condition of individual sections of road, detour routes, marking them, determining the boundaries of contaminated areas, areas of physical destruction, etc.

If a march is being executed in anticipation of engagement, main efforts are focused on reconnoitering the enemy. Strong reconnaissance patrols are established for this purpose.

Foreign military experts believe that the pace of conduct of reconnaissance is somewhat slower than the potential rate of movement of troop columns. Therefore helicopters and fixed-wing aircraft are employed in some armies to speed up the pace of conduct of reconnaissance. In the U.S. Army, for example, air reconnaissance at the division level is conducted by fixed-wing and rotary-wing aircraft of the aerial reconnaissance company of a reconnaissance battalion and army aviation battalion to a depth of 150 km. Of course these agencies conduct reconnaissance in close coordination with ground reconnaissance agencies, devoting particular attention to route reconnaissance and, if a meeting engagement occurs, they observe combat actions and adjust artillery fire.

Foreign military experts emphasize that reconnaissance missions can be successfully performed if not only reconnaissance but also march security subunits are assigned to this mission, as well as manpower and equipment from the main force columns.

Security. Modern conditions of movement of tank troops require organization of march security capable of ensuring unhindered movement of main force columns, of warning the protected troops of a surprise enemy attack, providing conditions for engagement and preventing penetration of hostile ground reconnaissance to the route of movement of the protected troops.

At the same time, foreign military experts believe that the situation and conditions of movement will demand great efforts in organizing such security. Increase in the effective range of offensive weapons and a rapid rate of closing of opposing forces require that security agencies be at a substantial distance from the main forces. In addition, an excessively large gap between forward subunits and the main forces impedes engagement of the main forces, does not help in seizing the initiative, and deprives a force of advantages in building up efforts upon encountering the enemy. Therefore at the present time it is believed in the armies of the NATO countries that troop security missions can be accomplished by coordinated efforts of reconnaissance, covering force and march security subunits, personnel and weapons assigned to security and defense of vehicles and facilities en route, as well as constant readines on the part of all subunits to perform particular combat missions pertaining to supporting the movement of the main forces.

In the absence of a stable front and threat of meeting engagements, many foreign armies follow the practice of sending out covering units. These units beat the adversary in seizing important positions, and support deployment and engagement of the main forces. They are also assigned the mission of conducting reconnaissance along the route of movement of friendly forces. In contrast to an advance guard, forward forces operate at a greater distance from the main forces, reach the destination earlier, and therefore encounter the enemy sooner.

As a rule security subunits are sent out a short distance ahead of the main forces. In the U.S. Army, for example, the advance guard of each division main force column includes up to a reinforced battalion. Depending on the situation, the advance guard should be far enough ahead to ensure gaining time and deployment of the main force column beyond the range of aimed artillery fire.

According to information in the foreign press, however, advance guards can be even further ahead, such as in those instances where more than 30 minutes is required for deploying and readying to fire those weapons moving up under the cover of the advance guard.

In executing a march deep to the rear of friendly forces, columns can be provided cover solely by immediate security. In the opinion of foreign military experts, under present-day conditions tank troops will experience great difficulties in organizing flank security, since it is capable of covering only a portion of the main force column of protected troops.

The little effectiveness of flank security is complicated in many instances by a lack of suitable roads. As a rule forced to travel on ill-suited, difficult roads or cross-country, flank guards have inevitably fallen behind their guarded columns.

Missions of covering the main forces in NATO armies are assigned to a subunit which moves as an element of the column on the threatened flank. At the same time the main force column is continuously air-patrolled. The column commander, upon receiving intelligence, immediately moves the designated subunit to the threatened sector. Stationary flank guards are set out where the threat of enemy advance and attack is most probable.

Under present-day conditions, traffic control and regulating have assumed exceptional importance. To the normal tasks assigned the traffic control service (regulating movement, monitoring and inspection to ensure that troops observe the established procedure of movement, camouflage and concealment measures), in connection with the threat of employment of nuclear weapons, are added such tasks as route security, conduct of radiological and chemical reconnaissance, engagement of enemy reconnaissance-raiding parties, assistance to control agencies in troop control, as well as securement of the organized movement of the local civilian population.

The increased volume of tasks evokes the necessity of increasing expenditure of manpower and equipment. Personnel and equipment requirements will be especially large during execution of a long-distance march. It is claimed abroad that under these conditions it will be necessary to assign to each route two traffic control details, which can perform their tasks sequentially by leapfrogging, at day's march intervals.

Some foreign military experts believe that one way to reduce expenditure of personnel and equipment on organization of traffic control and regulating is extensive adoption of the method of escorting columns by traffic control subunits. Such a method of regulating traffic is successfully employed, for example, in the armies of the NATO countries. Mobile regulating posts proceed at the head of the column in automobiles (motorcycles), halting oncoming vehicles by signals, and setting up stationary regulation posts where necessary. Another mobile post proceeds at the tail of the column, preventing the column from being overtaken and removing traffic controllers set out by the column-head mobile post.

Such a method of traffic control is also advantageous because it enables commanders to move columns confidently at maximum possible speed. This is due to the fact that commanders reconnoiter the route thoroughly and in advance, are thoroughly briefed not only on route condition, but also on alternate routes, detours, detours around built-up areas, obstacles, alternate river crossings, etc.

Escorting columns with a mobile traffic control detail, however, does not mean elimination of the system of stationary traffic control and regulating posts. There remains the need to set out stationary posts at railroad crossings, at river-crossing sites, and in large built-up areas, but their number is greatly reduced with the above traffic control variant.

4. Execution of a March

Depending on the situation of the troops, a march may be preceded by forming up march columns and moving them out past the start point, which requires a considerable time expenditure. In addition, reconnaissance entities, traffic control subunits, security and other combat support subunits are usually sent out ahead before the main forces proceed to move. All this, under conditions of an acute shortage of time, demands particular flexibility and efficiency in the performance of commanders and staffs.

The march begins at the moment when the start point is passed by the heads of the main force columns. The success of the march movement will depend to a certain

degree on how promptly troops pass this point and their degree of organization. It is therefore not surprising that in the past war troop passage of the start point would usually be monitored by staff officers. These officers, possessing information on the composition of the columns, their structure, and the precise schedule of departure of units and subunits, could when necessary take measures on the spot to impose order and ensured organized commencement of a march. Movement of march columns in the course of a march is usually controlled with intermediate passage points.

At the commencement of a march, in addition to control to ensure on-schedule troop passage of the start point and intermediate control points, commanders and staffs devote particular attention to ensuring that troops observe the specified march order and discipline, and ensure that columns move at the specified speed and in the specified direction. For this purpose, specially designated officers at control points monitor the state of the passing troops, collect situation data and report this data to headquarters.

We should note that the command experiences considerable difficulties in exercising continuous troop control, especially when particular tasks arise (crossing rivers, contamination zones, restoring battleworthiness, destroying airborne assault forces, etc). The main difficulty lies in the fact that control should be exercised in the course of movement of control agencies and troops with major restrictions in utilization of radio communication gear.

In order to overcome these difficulties, it is recommended in the foreign military press that command posts set up on helicopters be extensively utilized for troop control under these conditions.

Maintaining organization and discipline on a march ensures its successful execution. Columns and individual vehicles drive only on the right side of the road. Each vehicle proceeds in its assigned position in the column, maintaining the specified speed and gap. Vehicles which fall behind retake their places at the next halt. The necessity may arise for one column to pass another. This is permitted, however, only with the authorization of the senior commander and with observance of measures preventing accidents between vehicles and mixing up of subunits. When such a passing is required, the column being passed halts on the right shoulder or off the road to the right.

It is very important to ensure unimpeded passage of large built-up areas. In the past war tank troops as a rule slowed down considerably in towns and cities. Under present-day conditions, with a greater probability of formation of all kinds of obstacles in built-up areas, it is essential to endeavor to bypass them. If no bypass routes are available, traffic control is set up in built-up areas. Columns pass through built-up areas in the specified order, without halt, with increased gaps, and at the greatest possible speed.

Tank subunits and units may execute marches at night for purposes of concealment, at which time a complete blackout is particularly important. In this case drivers employ night vision devices. During daylight hours troops are dispersed along the routes back from the main road, observing camouflage and concealment procedures. During daylight hours personnel inspect and maintain equipment, take meals and rest.

Utilization only of the hours of darkness for executing movements, however, has the drawback that the pace of a night march is slower than that of a daylight march. Therefore, as is indicated by the foreign military press, troops may also move during the day, but in small, compact groups.

In the course of a march, when there occurs the threat of enemy employment of nuclear weapons, upon receiving an appropriate warning signal, the troops take requisite protective measures and continue moving. At the same time surveillance, radiological and chemical reconnaissance are stepped up, and appropriate instruments are switched on more frequently than usual.

When the enemy delivers nuclear strikes, those subunits which have maintained their battleworthiness shall continue moving in order to leave as quickly as possible the areas of physical destruction and heavy radioactive contamination. The commander and his staff shall estimate the situation, determine the status of the subunits which have been hit by enemy attack, and shall take measures to restore their combat efficiency. Neutralization of the consequences of nuclear strikes should not delay the movement of battleworthy troops. The roadway shall be rapidly clear of burned-out and damaged vehicles.

In the course of a march it may become necessary for tanks to negotiate a contaminated zone or to get out of such a zone as quickly as possible. Obviously the method of crossing a contaminated zone will be determined on the basis of levels of radiation in the zone, length of routes and possible speed of movement along them, as well as the demands of the operational-tactical situation. Contaminated zones shall be crossed at the maximum allowable speed in a direction ensuring the least degree of irradiation of personnel. These directions, as is noted in the foreign press, can be indicated by radiological reconnaissance by helicopter. In the contaminated zone gaps between vehicles shall be increased sufficiently so that dust from the vehicle ahead does not strike the following vehicle.

Contamination zones can also be bypassed, but usually with the permission of or on orders by the senior commander. This is due to the fact that bypassing always requires a route change. while an independent change of direction of movement without taking into account the missions of adjacent units can lead to crossing of routes and formation of traffic jams on roads.

Zones with high radiation levels, detouring around which is impossible or inadvisable, will evidently be crossed after high radiation levels drop off, by decision of the senior commander. After leaving a contamination zone, partial decontamination will be performed at the first opportunity (usually on halts and day's halts), casualties will be determined, as well as the degree of radioactive contamination of personnel.

During a march under present-day conditions, troops may be subjected to air attack at practically any distance from the line of contact. Therefore a high degree of preparedness to repel hostile aircraft and to diminish the effectiveness of airstrikes is maintained during the entire march and during halts. Troop actions on the appearance of enemy airplanes and helicopters can vary, depending on the situation. When natural screens are available along a road, a column shall halt

along a route segment sheltered from aerial observation. If movement is occurring on open terrain, subunits shall continue movement, increasing gaps between vehicles, and sometimes assuming a dispersed formation as well. All weapons which can engage hostile aircraft shall open fire.

Protection of moving troops against actions by partisan forces and enemy airborne assault forces assumes great importance under present-day conditions.

Foreign military experts believe that in order successfully to handle airborne assault forces and partisans, it is essential that all necessary measures be specified in advance, while the commander is formulating his decision and during preparation for the march.

It is pointed out that in the course of a march, with acquisition of intelligence on areas of partisan activities and enemy airborne assault forces, troops shall take measures to beef up reconnaissance, security of bridges and other bottlenecks on the immediately protected route. Columns are patrolled by helicopter gunships. It is believed that only minimal forces must be enlisted for aggressive actions against partisan forces and enemy airborne assaults, primarily reconnaissance subunits, march security, traffic control service, as well as subunits specially assigned to these missions.

The main body of troops should continue moving in order to reach the destination on schedule, maintaining a high level of combat efficiency. There may also occur departures from this principle, however. It is possible that tank subunits in the march formation will be called onto destroy airborne assault forces and raiding-reconnaissance detachments.

Thus the success of a march depends on thorough organization and comprehensive support, firm control and observance of discipline.